Railway Mechanical Engineer

Volume 96 October, 1922 No. 10

Machine Tool Prices Advance

Machine tool prices reached rock-bottom several months ago and from all indications, the present increase in prices may be expected to continue. Low prices in the early months of this year were caused essentially by the absence of buyers and the liquidation of large stocks of new machines in the hands of both manufacturers and the government. In their anxiety to sell, manufacturers were willing to make concessions in price which cannot be obtained at the present time. Reliable second-hand tools have also been largely disposed of and today few machines are in stock. With a scarcity of machines available, there are also unmistakable signs that both the railroads and general industry will be in the market for machine tools in the near future. This may be expected to accentuate the rising price tendency, the same result being brought about by an increasing cost of raw materials, such as pig iron and brass, together with increasing labor costs. In some localities it is difficult even now to get the skilled labor needed in making machine tools. In the early months of this year, certain railroads refused to order machines because they felt that prices were going still lower, but the error of this assumption is now apparent. Those who purchased machine tools six months ago not only secured them at a low price, but found them of great value in facilitating shop work during the strike. It is obvious that for the sake of early deliveries and in order to obtain as many machines as possible with limited appropriations, orders for machine tools should not be delayed.

The Greater Need for Foremen

About the busiest and most hard working man around any railroad shop or terminal is the foreman. The demands upon his time and ability were never more pressing. The position demands in the first place a knowledge of what work should be done, how it best can be performed under the existing conditions, and when it has been sufficiently and satisfactorily completed to meet requirements. What is even of more importance, he must know how to get along with and how to handle men and also must maintain a certain dignity without conveying the impression that he is without feeling and sympathy for the men working under his direction. He is the one who comes in direct and constant personal touch with the great body of workmen and, therefore, represents the management. The day in which a man's value as a foreman was measured by his ability to force men to perform a greater amount of work in a day than they otherwise would do has passed. The need is not for drivers, but for leaders. The successful conduct of the mechanical departments of American railways for a long time to come will depend upon the rebuilding of the shop organizations at this critical time. The foreman must be a good educator. Under present conditions it will not be possible for a foreman to handle as many men and secure satisfactory results as was the case even a short time ago. Instead of overworking an already busy foreman, far more can be accomplished by reducing the size of a department or gang or by selecting more sub-foremen. The foremen who have shown their loyalty and ability in the past should be supported and given a greater opportunity for time to think and plan their work.

Standard Practice Cards

Only a comparatively few railroads have reduced their maintenance of equipment standards to written form, either on cards or mimeographed sheets. Standard practice cards are valuable for many reasons, one of the most unexpected following directly as a result of the strike. New men, unfamiliar with car and locomotive repair work, but able to read drawings, can take the standard practice cards and follow instructions, performing the work satisfactorily with little or no supervision. In the majority of cases, however, these cards are not available and even capable machinists or mechanics, if unfamiliar with the work, need practically continuous supervision for a certain period. Some of the new men have shown a strong desire to acquaint themselves thoroughly with the various parts of cars and locomotives and learn the best methods of repairing these parts. Standard practice cards are invaluable for this purpose. Most roads, however, depend upon foremen and experienced workmen transmitting what is considered the best local practice to new men as they are employed. Another advantage of the cards is the assurance that good practices developed at one point on a system will be known and practiced throughout the system. Railroad men are notoriously backward in advertising themselves or giving publicity to new methods and devices which they have developed. If they are compelled to report these practices to the mechanical department for incorporation on standard practice cards, all the shops on the system will benefit by the latest and best methods. In view of the many advantages, it would appear that as fast as possible railroads should reduce to writing, arranged for convenient use, detailed information regarding the best recommended methods of overhauling, machining, or repairing all the essential parts of cars and locomotives.

Inspectors for Outside Repairs

The next few months undoubtedly will see a tremendous demand for locomotives and cars to handle the vast amount of traffic offered to the railroads. A realization of this prospect has led many roads to send a considerable number of locomotives and cars to outside concerns for overhauling. When the concerns selected are old established builders, the work can in most instances be performed properly with a comparatively limited amount of supervision and inspection. In other cases, however, contracts have been let to concerns that have had comparatively little experience in doing such work and have but a limited amount of suitable equipment or experienced workmen or foremen. In such cases the results obtained will depend to a large extent upon the men who are selected by the railroad and sent to overlook the

work while it is being done. The matters that will be referred to such an inspector and the points for which he will have to be on the lookout, demand a man with a broad practical experience, good judgment, firmness, and also the necessary tact and ability to secure what he wants without antagonizing those with whom he comes in contact. These are qualifications which are possessed by many foremen as they are essential to his success. At the present time, unfortunately, these men can poorly be spared from their regular jobs. The majority of regular material inspectors do not have the required practical experience. It will be necessary in many cases to select men who previously have not been used for such work. As the positions offer excellent opportunities for broadening a man's experience and would be of value to a man who has the qualifications needed for a foreman, those chosen should be men who afterward can be used in a supervisory capacity. As an assistance to these men and to find how they are developing, a general traveling inspector periodically should visit the various outside shops where repair work is being done.

Don't Kick the Same Brick Twice

This is a day of specialization, and fortunately so, because by this means articles are produced in great quantities at low prices, enabling modern workingmen to take as a matter of course luxuries unknown to kings a century ago. In spite of the benefits of specialization, however, men should not focus their attention so exclusively on one subject as to be blind to everything else that goes on around them. Such an attitude is not conducive to broadmindedness and it is doubtful if any man succeeds as well as he might even in his own specialty unless able to stand off occasionally and view it in relation to the work of others.

The various departments of railroad shops are highly specialized, and boilermakers, for example, cannot usually do machinists' work, or blacksmiths do boiler work. Yet the foreman who confines himself exclusively to the work of his own department and refuses to recognize or consider the work and problems of other departments, will never be in line for promotion. Successful higher mechanical officers have, almost without exception, been specialists in one branch of shop or roundhouse work, but have also acquired a broad gage, general knowledge of the work of all the other departments. There is altogether too much tendency for both foremen and men in one department to be disinterested in the work of another department, to the extent that they notice wastes of material, or costly methods of doing the work without saying anything about them. For example, if a boilermaker sees a 3-in. king bolt nut in a pit, it would require little effort on his part to pick it up and give it to the truck gang, or at least notify the foreman so that it could be saved and used over again. That may not be his main business, but it would benefit the road. If the cab foreman sees that the stripping gang is damaging cabs in taking them off, it is his duty to notify the erecting shop foreman, *and he usually does because it means extra work for his men.* He should be just as solicitous about mistakes which he observes while walking through the blacksmith shop.

Many times little jobs could be done by any one of several departments, but "what is everybody's business is nobody's business," as shown by the following story quoted from Factory: "A man stumbled over a brick in one of the walks between two shops the other day. He hurt his toes and cussed the brick. Five minutes later he returned the same way—kicked and cussed it again. Further watching showed that the same man kicked and cussed the brick four times in seven trips through the walk, and of the other men passing that way, two did the same thing within a space of 45 minutes. In all probability the brick is in the same place, being kicked because it is nobody's business to move it three feet to one side where it cannot possibly get in anybody's way." It is obviously foolish for any one to "kick the same brick twice." If all would get together to eliminate waste of time and waste of material in whatever department, the result would be immediately reflected in reduced cost of shop operation.

Roller or Ball Bearing Trucks

The use of roller and ball bearings has become quite general in many classes of machinery and has resulted in a considerable saving in the amount of power consumed. As their use has been so successful in some other fields, they naturally have been considered for passenger and freight car journal bearings. Early experience with anti-friction bearings on cars in this country was not successful and it is therefore of interest to note that a new type of roller bearing, which is expected to do away with the defects of formed designs, has recently been introduced on the Great Eastern Railway of England.

The savings that can be effected by ball or roller bearings have sometimes been greatly exaggerated. In figuring the increased train loads that might be hauled, if cars are equipped with anti-friction bearings, many people overlook the fact that grade resistance is the biggest factor in determining the train loads on most divisions and this is not affected in the slightest degree by a reduction of journal friction. Ball or roller bearings effect the greatest reduction in resistance at starting, which would be most advantageous in passenger service since it would eliminate the necessity for taking slack in many cases. At higher speeds a considerable reduction in resistance is also effected, although it is not in proportion to the decrease in the co-efficient of friction because the rolling resistance of the wheel on the rail and air friction are also important factors in train resistance. The maximum saving would probably be in the neighborhood of 20 per cent at 40 miles an hour, which would again decrease at greater speeds. A considerable amount of energy is expended in overcoming grade resistance and accelerating trains so the fuel saving for the entire run would probably be nearer to 10 or 12 per cent on an average division. The advantages of the anti-friction bearing would, of course, be greater on level track than on heavy grades.

Probably the additional expense of applying anti-friction bearings would not be justified unless there was an appreciable saving in fuel, although the maintenance—aside from renewals, which are still an indeterminate factor—might be considerably cheaper than with plain bearings. The present standard design is extremely simple, but it has the objection that its reliability depends upon frequent and expert attention. The bills for oil and waste in addition to those for inspection, constitute quite a large item in the expense of train operation. The results of tests of ball and roller bearings in regard to durability, reliability and savings in fuel and maintenance, will be watched with interest as this type of equipment affords attractive possibilities for reduction in the cost of transportation.

Copper Boiler Tubes and Fireboxes

The use of copper for locomotive firebox plates and boiler tubes was abandoned in this country many years ago. It is therefore interesting to note that this material will probably be tested again in actual service to determine whether it is more economical than steel under present conditions. The price of copper is now lower than it was before the World War, while the price of steel is more than 50 per cent higher. Furthermore, the cost of coal and wage rates are much higher than

formerly so that the conclusions which were reached under the circumstances existing 20 years or so ago may not hold good today.

One of the factors that caused the railroads to abandon the use of copper was the high cost of this metal. This is not such a serious objection, however, because the scrap value is very little less than the first cost and judging by experience in other countries, the life of the parts should be at least equal to those made of steel. An interesting discussion of the relative merits of copper and steel for locomotive boiler tubes occurred at a recent meeting of the Institution of Mechanical Engineers in Great Britain. One of the speakers at this meeting stated that copper tubes gave a mileage two or three times as great as steel and had only one-thirtieth as many failures. Except in very unusual cases, copper tubes do not corrode or pit and they are, therefore, suitable for use in bad water districts. There is a question, however, whether copper tubes would not set up a galvanic action that would cause corrosion if used with steel firebox plates. In Great Britain the firebox plates as well as the tubes are of copper. The statement is often made that copper tubes save a considerable amount of fuel although little evidence is presented that might be considered conclusive. As has been pointed out before, the limiting factor in heat transmission through boiler tubes is probably the rate at which the heat is transferred from the gas to the tube and, therefore, copper may not give any better results than steel even though it has a heat conductivity eight times as great and does not accumulate as much scale as does steel.

P. C. Dewhurst of the Jamaica Government Railways, who has had experience with both materials, states that he does not see sufficient justification for the use of copper tubes unless it is because of better conductivity. Owing to the high coefficient of expansion of copper, the tube sheets are distorted more between the cold and working temperatures than when steel tubes are used and furthermore, Mr. Dewhurst states, steel tubes do not suffer from eroding at the firebox end, just inside the tube sheet. It is evident that each material has certain important advantages and it will be interesting to note the results of comparative tests which should end the futile theoretical discussion.

Effect of Power Plant Practices on Locomotive Design

A COMPARISON between the modern steam locomotive and the modern stationary or marine power plant shows a striking difference in fuel consumption per unit of power delivered. Noting this difference, many casual observers have jumped at the conclusion that the days of the steam locomotive were numbered and that electrification with economical central power plants and motor-driven trains should be practically universally adopted. But the greater economy of the central power plant is offset by the losses in transmission and by the higher cost of the equipment and, therefore, electric locomotives do not realize the full advantage of the stationary plant.

If the comparison is carried further and other factors besides fuel economy are considered, additional striking differences become apparent. On the one hand is the steam locomotive with its high-capacity boiler and its simple reciprocating non-condensing engine, a remarkably compact unit of relatively low weight per horsepower, easy to operate, low in initial cost and so simple that it can be repaired and maintained readily by types of mechanics of whom a large number are available. However, it can be operated only a few hours continuously and consequently makes only a limited mileage in the course of a year. Considerable non-productive time is spent at terminals or in the shops due to the necessity of cleaning fires, inspections and care of boiler or machinery. In this respect it must be acknowledged that the electric is superior to the steam locomotive.

On the other hand, the stationary power plant occupies a large space and an expensive building. The total weight of machinery per horsepower and the financial investment is large. In addition to boilers, turbines and generators, there is a considerable amount of auxiliary machinery. The condenser alone is bulky and requires a large amount of circulating water to condense the steam. The operation must be under the control of a well-trained engineer. Such a plant can be operated, however, for long periods of time without shutdowns for inspection or for repairs.

Hitherto locomotive development has been mainly in the direction of greater capacity with certain additions, such as superheaters and feedwater heaters, which increased the boiler efficiency, but the engine has still remained a simple, non-condensing one. Compounding has been used to a certain extent, but is now rarely employed except for locomotives of the Mallet type. Condensing has not been resorted to on account of the size and complications of a condenser and because of the lack of space for the larger cylinders that would be required.

Steadily increasing fuel costs are bound to bring about marked increases in the overall efficiency of the steam locomotive. In seeking ways in which this can be attained, advantage should be taken of the engineering practices for the best stationary power plants. Turbines and reduction gears have reached a high degree of efficiency and at the same time are reliable and remarkably compact. Engineers in a number of countries are giving serious thought to their adoption as a substitute for the present reciprocating locomotive engine. Some of the most valuable work which has thus far been done in this direction has been carried out by the Ljungstrom brothers in Sweden. After a vast amount of pioneer investigation, they have constructed a locomotive which shows a remarkable increase in efficiency when compared with that obtained with any reciprocating-engine locomotive ever built.

From a description of this locomotive, which is given in this issue, it will be noted that many stationary power plant practices which have helped to increase economy have been included in the design. The feedwater is raised to about 300 deg. F. by a three-stage heater fed by exhaust steam from the various auxiliaries. A turbine-driven exhaust fan is used to create the necessary draft. Instead of lengthening the boiler tubes in an attempt to transfer a little more heat from the gases of combustion to the water in the boiler, the tubes have been shortened and the surplus heat employed to raise the temperature of the air before it is admitted to a closed ash pan. The steam from the main turbine is condensed and a high vacuum secured. The feedwater is used over and over, thus reducing to a minimum the formation of boiler scale. The condenser being of the air-cooled type, it is not necessary to carry a large quantity of cooling water. A tube blower has been installed to keep all tubes free from soot. The steam pressure and degree of superheat also are notably high.

The Ljungstrom turbine locomotive is worthy of careful study because of the radical departure from all established standards of locomotive practice. The designers have unquestionably succeeded in their endeavor to increase the thermal efficiency. It remains to be seen whether such locomotives can be readily maintained with ordinary facilities and whether they can be built to give the high power output required to meet operating conditions in this country. Nevertheless, this will stand as an epoch-making locomotive. It seems certain that future progress will be along the lines of adapting to the locomotive the principles which have been instrumental in bringing the stationary power plant to its present high state of efficiency and reliability.

What Our Readers Think

Poor Box Car Door Fasteners

Roselle Park, N. J.

To the Editor:

While walking through any large freight car yard, one still observes many defective box car doors and fixtures. Some of these give the appearance of extending an invitation to burglars.

Considering the severe duty that a box car door is subjected to, it is surprising to find many of them equipped with door fixtures that are too frail, causing them to break or to become otherwise defective. Common defects are: Door hasp bent or broken; wooden door stops split, loose or broken; door track loose; door guides and lower door angle too short; door hanger sheave pins worn out or door hangers bent; door lock sealing plates too weak. Some of the bottom hung doors can only be operated with the aid of a crow-bar and the combined strength of several men.

Regarding wooden or reinforced wooden doors as applied to the older classes of cars, it is altogether too easy in many cases to force an entrance into such loaded cars without breaking the seal, thus permitting pilfering of freight to a much larger extent than would be the case were good substantial door fixtures applied according to A.R.A. standard box car door sheet, Drawing 30A. Car Inspector.

Mutual Confidence Would Settle Railroad Troubles

Green Cove Springs, Fla.

To the Editor:

The development and history of our railroads has been one continuous struggle, first, to produce a machine that would replace the horse, then to construct a road that the prime mover could haul loads over, then to secure the money with which to purchase equipment and extend lines, then to develop the country served to a point where it would support the investment represented by the road.

The building of our great railroad systems, from the ground up, was a huge work and required the full powers of such men as Hill, Vanderbilt and Harriman—exceptional engineers of American progress. The only way in which they could possibly make a success of their undertakings was to benefit, through service, the country through which the railroads ran. Mr. Hill went to Europe and purchased a carload of black bulls and distributed them along his road, that the farmers might have a better grade of beef stock and make more money. This is a simple instance of how alert these men were to help the people that their roads served, and it goes without saying these same people were as much interested in the roads as it was possible for them to be. When a prosperous year came and they had money to spare, they loaned it to the roads. The relationship was mutual, harmonious and good.

Passing from this early and altogether fine condition, comes a period of financial exploitation of our roads. During this same time the confidence of the people in the railroads was shaken, the sources of supply for railroad capital were destroyed, and they found it almost impossible to secure the money needed to keep the systems in working order. To meet this, rates were increased and more water added, then another increase in rates until the Interstate Commerce Commission was created and the roads were subjected to a period of drastic regulation.

Along with this sweating process that the roads have passed through has come the loss of confidence between employer and employee, or more properly between employees, since all are employees of the road. This breech among workmen is perhaps one of the very hardest to remedy or remove. The loss of good will among any group of workmen cuts deep into the profits of their employers. When workers are loyal to their tasks and to their leaders, they are properly poised, in the correct frame of mind to enjoy their work, and there will be a maximum production of good work. Without this same good will, no amount of pay will create the incentive that will get results. Therefore, the first thing for the roads to do is to have all the employees and all departments get together. It is especially important that the railroad officers should work to win the confidence of the men under them. There is as much departmental and official mistrust as exists among the ranks of the workers. Everybody must take it upon himself to instill confidence in all with whom he has dealings. In this way and only through the restoration of mutual confidence will permanent good come or the day of strikes be past. A strike is only the advertisement to the outside world that a group of workers have lost faith in the management. A strike reflects discredit upon the entire enterprise. A negative state of mind antagonizes profitable production. In every walk of life—political, industrial, religious, or military—a leader only leads as long as he is able to retain the confidence of his followers. We need to stop, look back and fashion our relationships after the examples of some of the early railroad makers.

The time has come when strikes in any one of our public service industries should be abolished. Any labor dispute in the fields of transportation, communication, food, fuel or clothing (perhaps also protection) should be settled by a commission, and its decision should be final in all cases without resort to strike. After all, this is only saying in so many words that the public will be served, that the public will pay for the service it gets and that it will not be charged excessive rates; that all employees in the industries mentioned will get a square deal, a fair wage rate, and otherwise be treated on a par with the same class of workmen in other lines; that those in executive stations will have the assurance of constant full production. The first result that will come out of this new order of management will be increased loyalty, large production and increased savings accounts for the workers and better returns for the companies involved.

I do not think the effects of a strike can be measured; the spirit of rebellion kills our national life, our patriotism is lowered, our standards of citizenship suffer; it is a blight that seriously affects the nation. Therefore, if we are to continue as a great nation, we must remove the conditions that cause workmen to mistrust each other and advance from this age of strike to one of a better understanding; we must advance to the newer day with the confidence and loyalty of the early days in railroading. The future leaders must have thorough training in human nature and relationships. A broader view of human frailty and faith in the old, old rule that "We help ourselves most when we are serving the other fellow for the sake of service and its invisible rewards" was never more essential than at the present time and cannot be overlooked in the future.

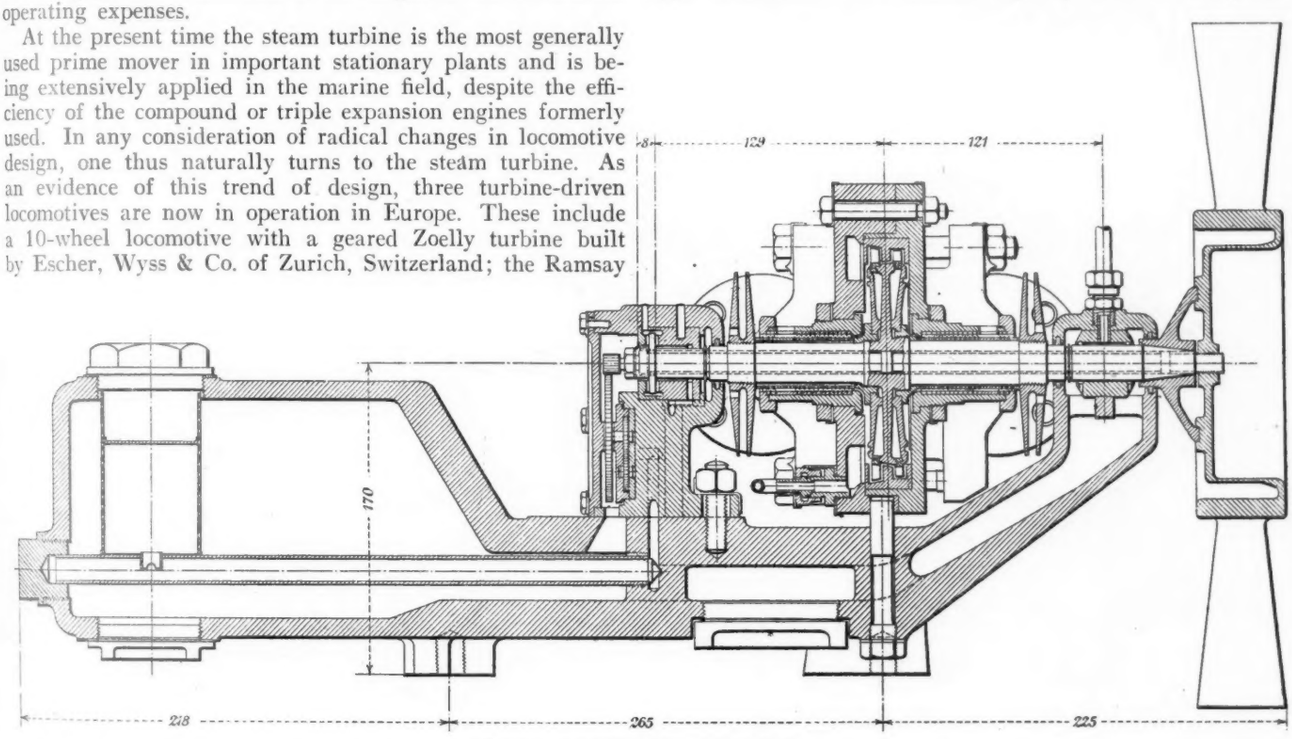
I have worked in railroad shops and have first-hand understanding of the workers' lot. I have worked with some of the leaders in minor positions and been in contact with men who have had considerable authority and also know that their pathway is not especially strewn with roses. I have a very profound sympathy for them all and because the work they are to do is so necessary, it seems a pity that this distorted relationship should have crept in and upset everything leading to progress. Frank Roberts.

The Ljungstrom Turbine-Driven Locomotive

Remarkable Efficiency Shown in Swedish State Railway Tests by Locomotive with Many Striking Features

WHEN it is recalled that the superheated-steam locomotive converts only about six to eight per cent of the heat value of the coal consumed into useful work, whereas from 15 per cent to 19 per cent is converted in modern power plants, it is apparent that there is room for large improvements in locomotive efficiency. The importance of the matter stands out prominently at the present time on account of the world-wide increasing cost of fuel. While this increase has not been as pronounced in this country as in Europe, fuel is still one of the largest items of railroad operating expenses.

At the present time the steam turbine is the most generally used prime mover in important stationary plants and is being extensively applied in the marine field, despite the efficiency of the compound or triple expansion engines formerly used. In any consideration of radical changes in locomotive design, one thus naturally turns to the steam turbine. As an evidence of this trend of design, three turbine-driven locomotives are now in operation in Europe. These include a 10-wheel locomotive with a geared Zoelly turbine built by Escher, Wyss & Co. of Zurich, Switzerland; the Ramsay turbo-electric locomotive of the 2-6-6-2 type and 22,000 lb. tractive force on the London & North Western, England, built by Armstrong, Whitworth & Co.; and the Ljungstrom geared-turbine locomotive of 30,000 lb. tractive force on the Swedish State Railways. A very complete description of the Swedish design has been given in recent issues of Engineering (London) to which the *Railway Mechanical Engineer* is indebted for most of the information and illustrations used for this article.



Turbine Driven Induced Draft Fan

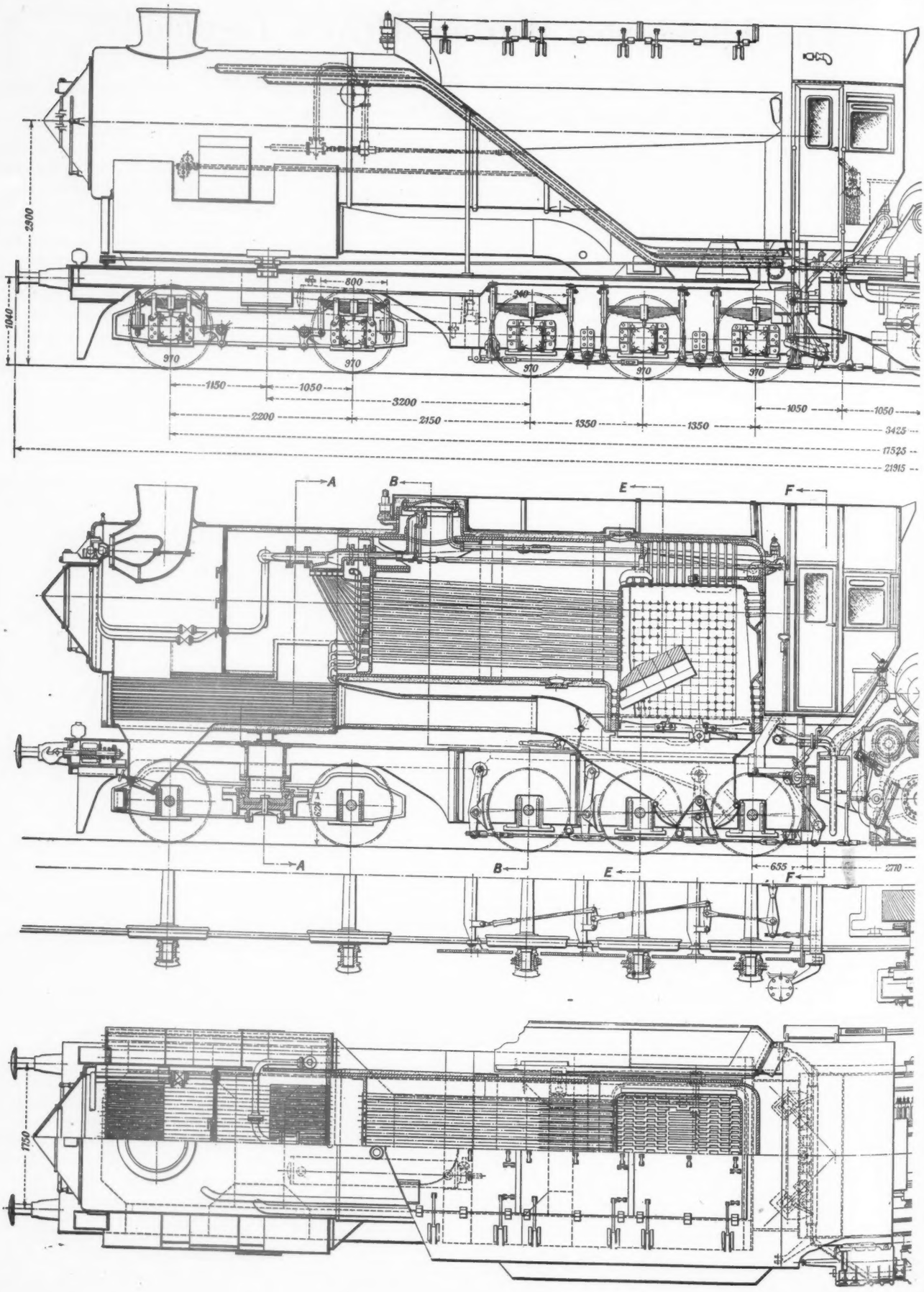
Object and General Description of Design

The design is largely the work of Fredrik Ljungstrom, assisted by his older brother, Birger Ljungstrom, general manager of Aktiebolaget Ljungstroms Angturbin, at whose factory near Stockholm the work of construction was carried out. In regard to running gear, boiler design, locomotive practice and requirements, the engineers of the Swedish State Railways collaborated with the builders. By combining the knowledge of an old established manufacturer of turbines and power plant equipment with that of practical railroad engineers, an epoch marking locomotive has been brought out after a vast amount of investigation and preliminary experimental work. In working out the details the object aimed at was to adapt the most advanced power station practices to the space and weight limitations of an ordinary locomotive and still retain the relatively high efficiency, reliability and possibility of long continued operation without inspection or withdrawal from service for repairs to boiler or machinery. Bearings and running parts have been enclosed as far as possible. The feed water is used over and over, thus reducing the amount of scale and necessary boiler work to a minimum. Tests in regular service have shown a fuel consumption of less than half that of standard type locomotives of a similar capacity when hauling the same trains. The small size of the boiler and the little coal required are striking proofs of increased efficiency.

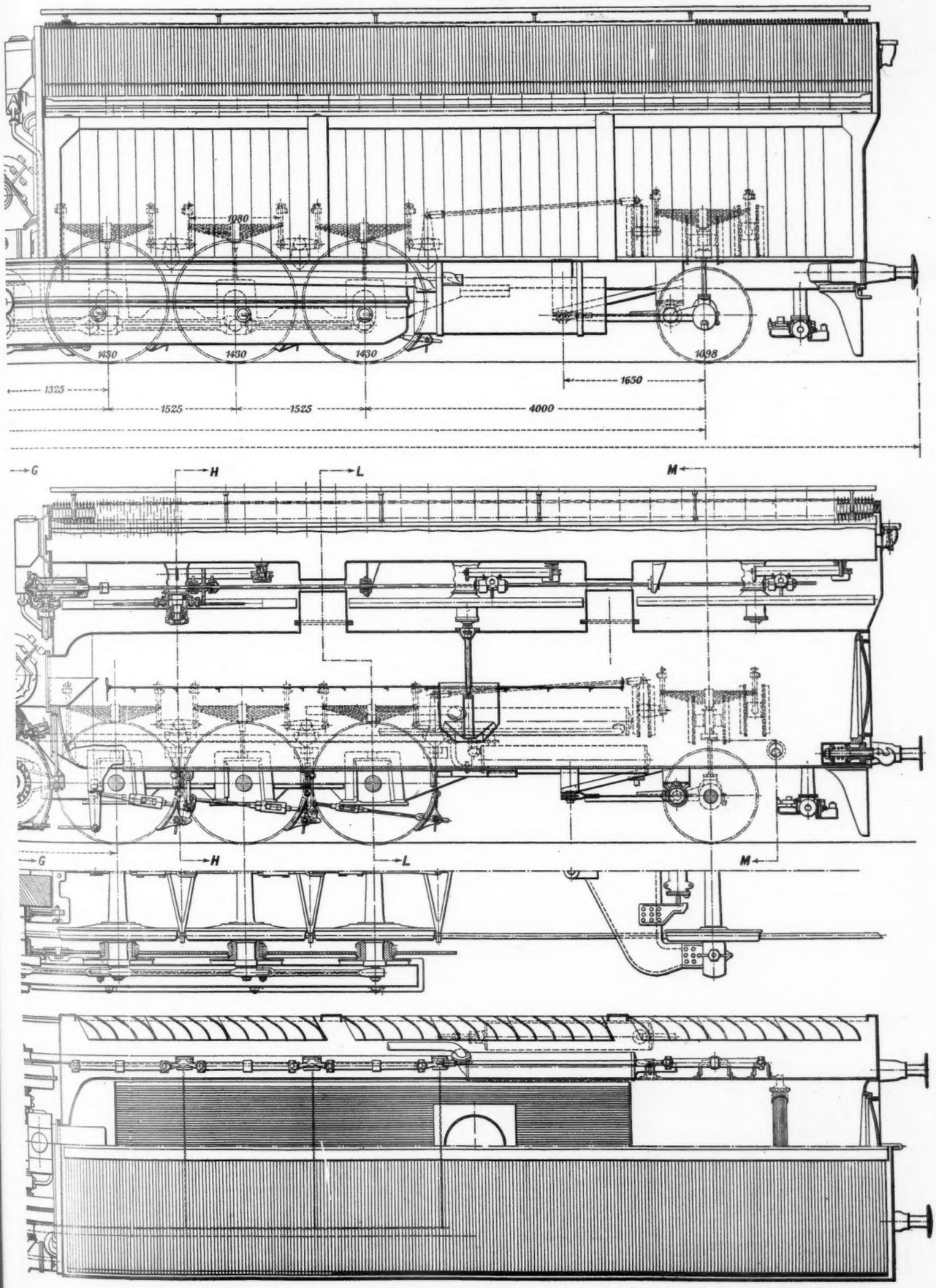
It will be noted from the drawings that the locomotive consists of two parts, a boiler unit and a condenser unit. The forward half, containing the boiler and coal bunker, weighs 138,800 lb. and is carried on a four-wheel leading truck and three pairs of wheels with boxes and pedestals of ordinary European design. All ten wheels are of 38¼ in. diameter and are used simply for carrying the weight. The rear unit, in addition to the condenser, carries the turbine, reduction gear and part of the auxiliary machinery. It weighs 143,360 lb. and is carried on three pairs of coupled driving wheels, 56¼ in. diameter, and a two-wheel trailing truck with 43¼ in. wheels. The weight on the driving wheels is 107,520 lb. and on the trailing truck, 35,840 lb.

Boiler and Air Heater

The boiler carries 285 lb. steam pressure and is of the straight top type, 66 in. outside diameter, with a firebox 63 in. long by 63 in. wide which gives a grate area of 28 sq. ft. There are 160 tubes, 3 in. outside diameter and 9 ft. 10⅛ in. long between the tube sheets. The evaporative heating surface includes 108 sq. ft. in the firebox and 1,130 sq. ft. in the tubes, a total of 1,238 sq. ft.



Elevation, Sections and Plan of



Ljungstrom Turbine-Driven Locomotive

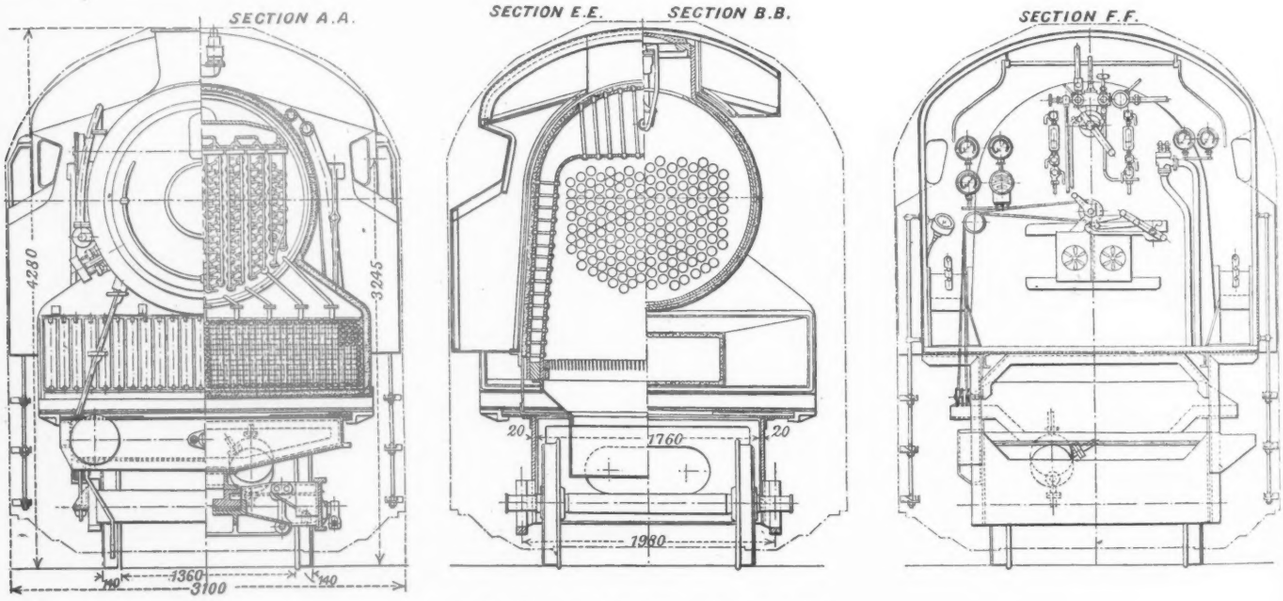
The length of the tubes is only about two-thirds that of ordinary locomotive boilers. This was decided upon because it was thought that greater economy could be secured by utilizing the surplus heat contained in the gases for preheating the air required for combustion. This is believed to be the first instance in which an air preheater has been used on a locomotive.

The smokebox is divided into two portions by a transverse diaphragm which causes the gases to pass down and through the air heater before going to the stack. This heater which is located beneath the smokebox contains 650 longitudinal brass tubes, 1.3 in. outside diameter, 8 ft. 11¼ in. long and with a heating surface of 1,787 sq. ft. The gases leave the boiler tubes at about 610 deg. F. and are cooled to about 300 deg. F. in passing through the air heater while the air for combustion is raised to about 300 deg. F.

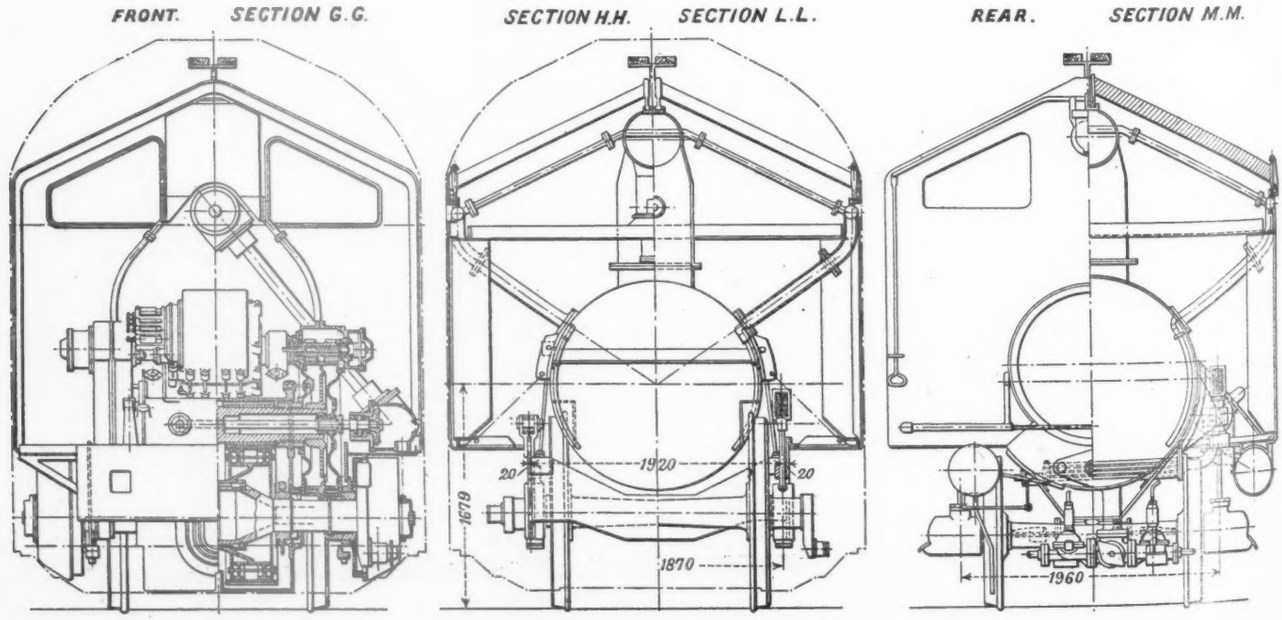
The front portion of the air heater casing is extended downward to form a hopper in which soot and dust can collect and from which they can be discharged at will. A large duct connects the rear end of the air heater to the closed ash pan. The supply of air to the ash pan is controlled by a series of vertical shutters or dampers which cover the front end of the heater and can be opened and closed from the cab. The handle by which they are operated is interlocked with the firedoor in such a way that they are closed automatically when the firedoor is opened, thus avoiding the danger of flame or gases being blown back into the cab when the door is opened, while the locomotive is running. There is also an additional damper in the duct to the ash pan for further regulation. The coal is carried in a saddle bunker of seven tons capacity, mounted on top of the boiler and extending from the front of the dome to the cab. Its tapered form serves to bring the coal to doors opening to the foot plate on each side of the firebox where it is most convenient for the fireman.

Induced Draft Fan

As the exhaust steam is all condensed, it becomes necessary to use a fan to create the required draft. As will be noted from the drawings, the stack has an extension reach-



End Views and Sections of Boiler Unit



End Views and Sections of Condenser Unit

ing down into the front compartment of the smokebox, and carried forward where it terminates in an annular opening with a horizontal axis. A turbine-driven fan is mounted on the front of the locomotive with the fan blades close to the annular opening to the stack and serves to draw the gases from the smokebox and force them through the stack. The cooling of the gases to 300 deg. F. while passing through the air heater also reduces their volume, both of which simplify the fan problem. The maximum speed of the fan is 10,000 r.p.m., at which speed the turbine develops 40 hp. The front end projects from the smokebox and contains an oil reservoir and pump.

The turbine consists of a single impulse wheel with two rows of rotary blades. The blades are welded up into a complete ring and clamped to the center disc by two plates. The turbine shaft is hollow and carries a central spindle to which the fan is attached. The turbine works at full boiler pressure and exhausts against a back pressure of 75 lb. to the high pressure feedwater heater or to the main turbine.

The fan impeller is machined from a solid steel disc and the hub is counterbored from both sides to give a flexible connection and permit the rim and blades to rotate about their own center of gravity and run without vibration.

Superheater and Tube Blower

All tubes contain superheater elements. Each element is heated by the gases passing through two tubes, the superheater pipes making four passes through the first tube and then four through the second tube before returning to the header. The length of each pass is shorter as the steam becomes superheated. The superheating surface is 861 sq ft.

Provision has been made for blowing the soot out of the tubes, the mechanism being operated from the cab. A horizontal steam pipe extends across the front tube sheet above the top row of tubes, and to this pipe is connected a series of smaller vertical pipes between each alternate row of tubes. These small pipes have drilled holes opposite each tube opening. When the engineman desires to remove the soot from the tubes he can admit steam to each one of the vertical pipes in succession. As extensions of the pipes pass down into the air heater, boiler tubes, superheater elements and air heater tubes are all cleaned at the same time. The tubes being blown in small sections, there is no appreciable interference with the draft, such as would result if all tubes were blown at the same time.

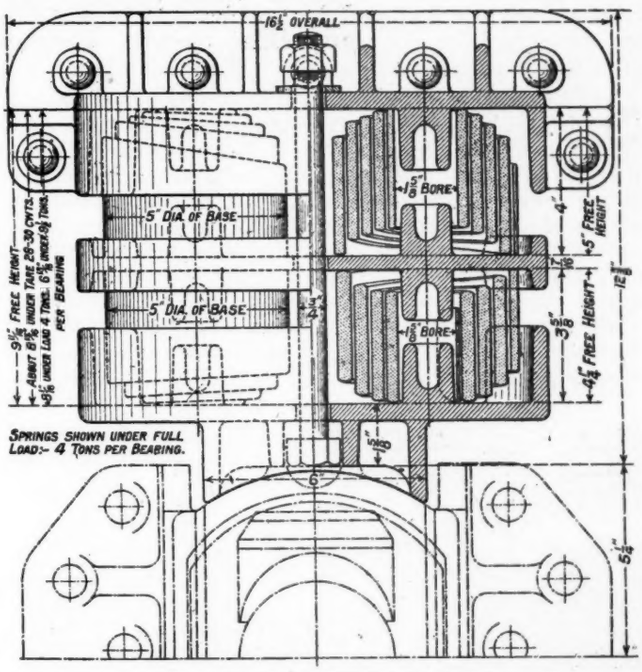
(*Description will be continued in the next issue*)

Volute Journal Box Springs

COMPARATIVELY few volute springs are used on American rolling stock although they are by no means unusual in European practice. The accompanying illustrations show an application of volute springs to the journal boxes of a six-wheel tender on the Bombay, Baroda & Central India railway. This differential bearing spring gear, which is known by the trade name "Herculo," was designed by A. H. Sheffield and manufactured by F. R. Rand & Co., London. Springs of the general type are suitable for use with journal boxes on any pedestal type truck and are used on passenger and freight service cars as well as on locomotives and tenders.

In this particular installation the springs are arranged in a group of four for each box, each group consisting of two upper and two lower springs in series. The upper springs are of a lighter section and will, therefore, deflect under a load a greater amount than the lower group of springs, thus insuring easy riding conditions whether the tender is empty or loaded. The total stroke is divided between the upper and lower springs and as the springs are wound in reverse directions, they have different periods and oscillation is damped out.

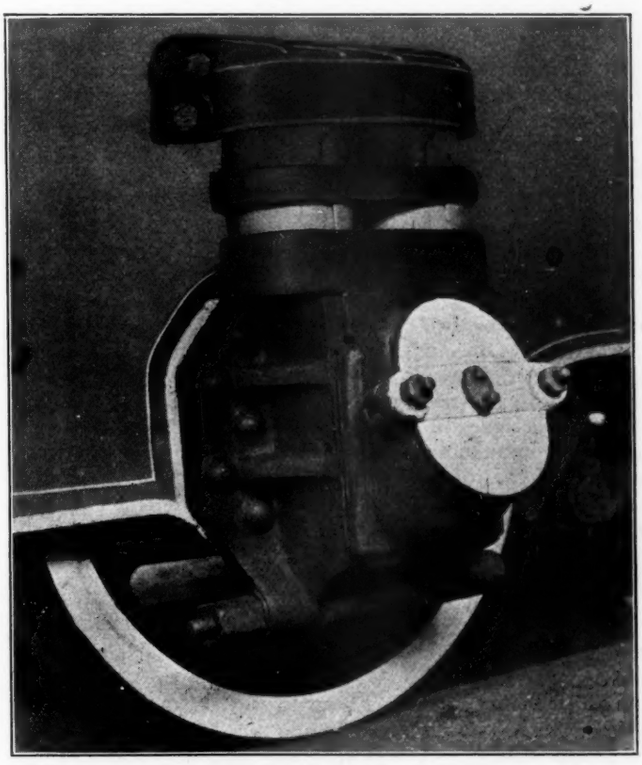
Referring to the drawing which is reproduced from a description in the Railway Gazette, London, the upper steel casting is bolted to the tender frame while the lower casting rests on top of the journal box. The through bolt is



Construction of Differential Spring Gear

provided to hold the lower casting, the springs and the intermediate collar together when the tender frame is lifted from the wheels and axles.

These springs are also reported to have given good satisfaction on locomotive trailing trucks and where they have been used the flange wear has been slight.



Differential Spring Gear Applied to Tender

Dynamometer Tests of the Locomotive Booster

Severe Trials Demonstrate Reliability at Heavy Loads and High Speeds—Maximum Drawbar Pull 11,000 lb.

SINCE the advent of the locomotive booster, which was first applied early in 1919, numerous tests have been made in road service but up to this time little information has been available regarding the mechanical efficiency of the device or the power which it develops. While the results of actual operation can be studied best on the locomotive, it is necessary to test the booster independently if its performance as a machine is to be determined. With this in mind, the Franklin Railway Supply Company, New York, recently conducted a thorough dynamometer test of the latest type of booster. The purpose of the test, which was made under the direction of Dr. Harvey N. Davis, of

Fig. 1—The Test Plant, Showing Boiler (at left), Booster and Condenser

the Engineering School of Harvard University, was to determine accurately the ability of the booster to stand up satisfactorily under continuous heavy loading and operation at high speed, the power which the booster will deliver under varying conditions of speed and boiler pressure on a locomotive, the steam consumption per brake horsepower hour or drawbar pull under such conditions and the mechanical efficiency.

Description of the Booster Engine

The Type C-1 booster which was tested is a 10 in. by 12 in. double-acting two-cylinder engine with cranks set at 90 deg. Some of the important mechanical features of the design are as follows: The gear ratio between the booster engine shaft and the trailer axle is 14 to 36. The engine frame is designed to withstand the stresses imposed upon it with the minimum strain and the gear cover has been made an integral part of the casting. The bearings in the trailer axle boxes have been made larger and an oil tight case has been provided for the trailing axle gears, affording splash lubrication of these parts. The rocker design has been changed to relieve the bottom journals of all stress and stops have been so placed that the pitch circles of the gears are held in the proper relative position at all times. The engine case has been fitted with an oil tight cover which is easily removed and replaced. A new design of manifold for the live and exhaust steam has been applied at the rear of the cylinder with large cross section in the passages to reduce the steam velocity. A manifold has also been attached to the crank case to receive all air connections. The appearance of the booster is well illustrated in Fig. 1 which shows the machine connected to the dynamometer shaft with the cover of the crank case removed and the rear end elevated.

The Test Plant

The test equipment was designed especially for this test and for the routine test under load to which all boosters are subjected after assembling at the factory of the Poole Engineering & Machine Company, Baltimore, Md. The steam plant consists of a 250 hp. Heine boiler with a low temperature superheater and a feed water heater connected in parallel with and draining into the main condenser. The test bed carries a shaft and 18 in. gear, similar to a standard trailer axle gear, direct connected at one end to a prony brake. The steam pipe from the boiler to the test bed is fitted with a gage to show the inlet pressure and a thermometer to indicate the superheat, which ranged between 30 and 35 deg. F. in most of the tests. A second pressure gage is located about 30 ft. back from the inlet gage, the piping between duplicating that on a locomotive. Pressures read on this gage are called throttle pressures in the report and correspond to the boiler pressure on a locomotive.

The booster was operating on the test plant during four

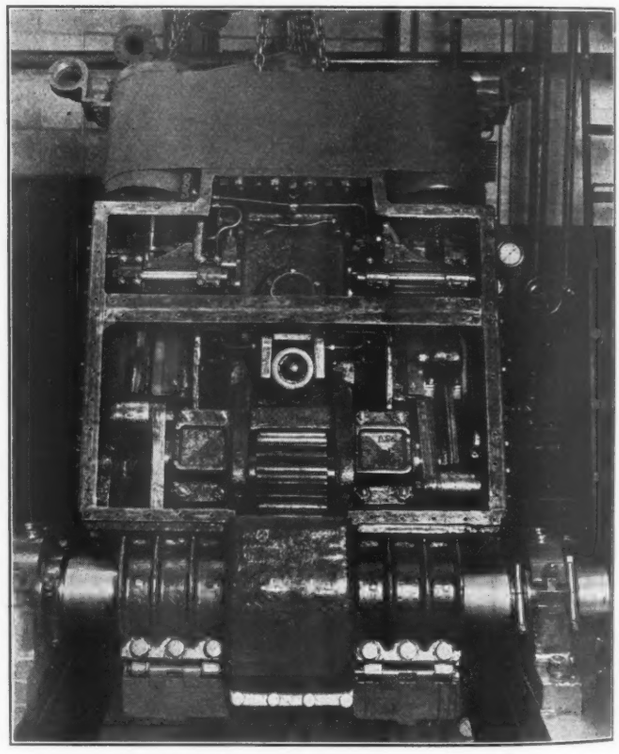


Fig. 2—Top View of the Booster, with Cover Removed

days under a wide variety of conditions ranging from stalling tests to high speed runs at 22 m.p.h. Some of the trials were made with the exhaust piped to the condenser to measure the steam consumption and others with the steam discharging to the atmosphere through 40 ft. of 4 in. pipe to duplicate roughly conditions on the locomotive. The tests represented an equivalent run of about 92 miles as of a 45 in. trailer wheel, most of which was made under heavy load.

During each of the tests the speed and boiler pressure were held as nearly constant as possible. Indicator cards were taken and records made of the speed, the brake load, steam pressure and temperature and steam consumption.

From the data thus obtained the details of the performance of the booster were determined as set forth in the following paragraphs.

Mechanical Efficiency

The mechanical efficiency of the booster, or the ratio of the power delivered at the rim of the trailer wheel to the power developed in the cylinders, is plotted in one of the curves on Fig. 3. It will be noted that it varies from 90 per cent at 6 m.p.h. to a maximum of 95 per cent at 14.5 m.p.h. dropping slightly at higher speeds. The mechanical efficiency of the booster does not change with the steam pressure over the limited range met with in practice.

These mechanical efficiencies seem very high but the explanation of the excellent results is to be found in the high efficiency of the gear arrangement, the effective lubrication and the unusually high mean effective pressure. A typical curve of the brake horsepower, which corresponds with the

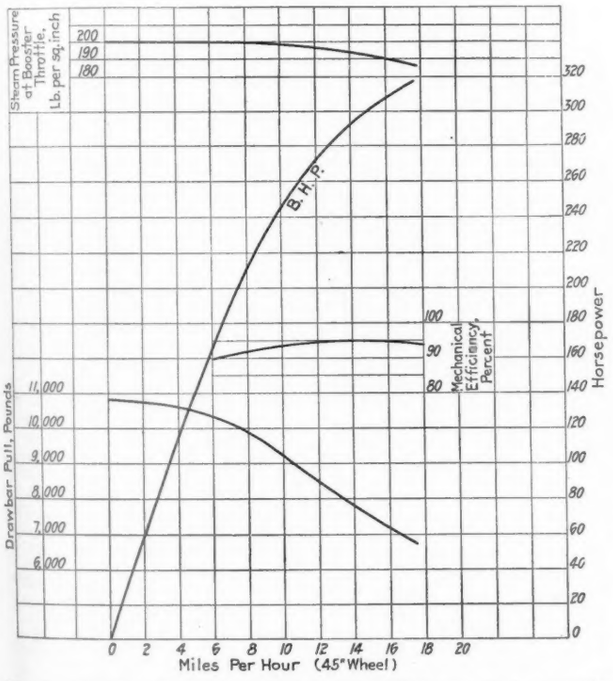


Fig. 3—Drawbar Pull, Horsepower and Efficiency of Locomotive Booster

power delivered at the trailer wheels, is also plotted in Fig. 3. The steam pressure dropped somewhat during this test and with a pressure of 186 lb. at the booster throttle at 17.8 m.p.h., 316 hp. was developed.

Tests showed that at any given speed with a given exhaust connection the brake horsepower is proportional to the gage pressure at the booster throttle but does not vary with superheat.

Drawbar Pull

A typical curve of the drawbar pull as obtained during the tests is shown in Fig. 3. For convenience in predicting the drawbar pull curve of the booster on any particular locomotive the chart of Fig. 4 has been plotted for speeds from 0 to 25 m.p.h. and boiler pressures from 140 lb. to 200 lb. gage.

In using this chart the pressure that can be maintained at various speeds by the boiler supplying the booster is estimated and the corresponding points are plotted on the chart, using the pressure lines as guides. A constant pressure equal to the boiler pressure of the locomotive can be realized over the entire speed range if the cut-off in the main locomotive cylinders is shortened enough at each speed to keep the steam consumption of the main cylinders and the booster cylinders within the limit of the capacity of the locomotive boiler. It will be noted that with 200 lb. pressure the type C-1 booster delivers a pull of 11,000 lb. at starting and at 20 miles an hour is still giving nearly 7,000 lb. at the drawbar.

Steam Consumption and Water Rate

To show the steam consumption of the booster under conditions identical with those plotted in Fig. 4, Fig. 5 has been

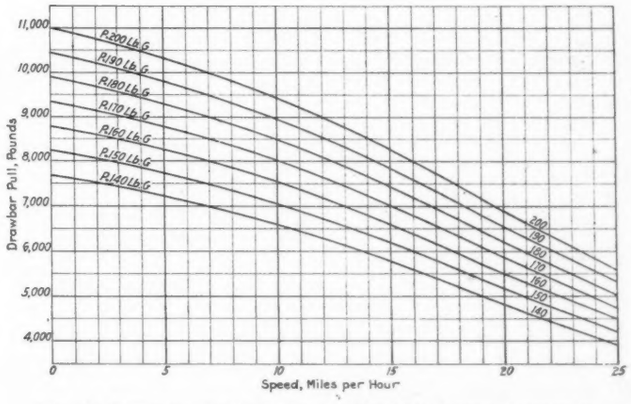


Fig. 4—Drawbar Pull Curves at Various Steam Pressures

drawn. The values given by this chart are based on superheat of 30 deg. F., the average value during the tests. The steam consumption is assumed to decrease about one per cent for each 6 deg. F. increase in throttle superheat. If saturated steam were used the consumption would be approximately five per cent greater than shown and if highly superheated steam were used, the values would be materially less.

The water rates as determined from the tests varied from 40.8 lb. to 43.4 lb. per brake horsepower hour. These rates

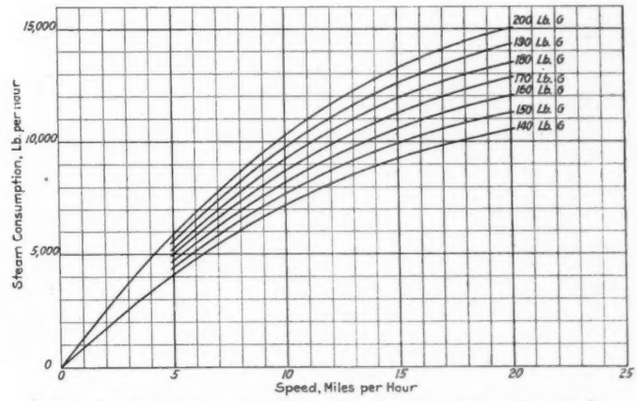


Fig. 5—Steam Consumption at Various Boiler Pressures

are, of course, subject to the same variation due to superheat as the steam consumption shown in Fig. 5.

Application to Operating Conditions

The manner in which the data obtained in the test can be used to determine the performance of the booster in actual service is illustrated in Fig. 6. This shows the increased hauling power and increased acceleration that can be obtained when the booster is applied to a Pacific type freight locomotive. In the chart the drawbar pull exerted by the locomotive or required to pull the train is plotted ver

tically and the speed in miles per hour is plotted horizontally. The drawbar pull required for a 2,500 ton freight train, averaging 40 tons per car, on level and on grades up to 0.8 per cent is shown in the series of dotted lines. The lower solid line shows the drawbar pull of the locomotive without the booster and the upper line the drawbar pull with the

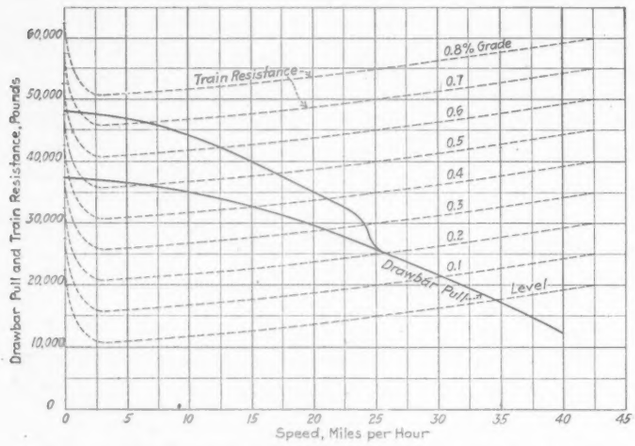


Fig. 6—Performance of Pacific Type Locomotive Hauling 2,500 Tons With and Without Booster

booster in operation, on the assumption that the booster is cut out at about 23 m.p.h.

Assuming the train is starting on level track it is evident that the locomotive without the booster can exert drawbar pull considerably greater than the train resistance. The difference between the drawbar pull of the locomotive and

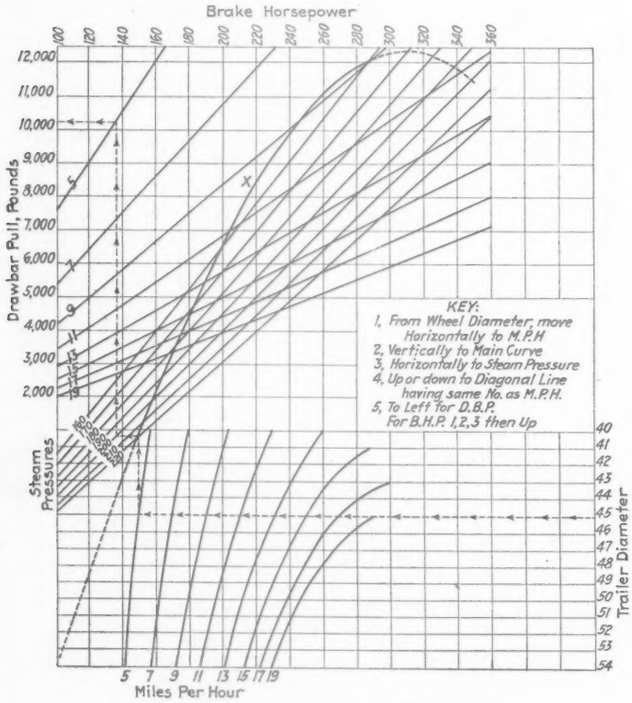

Brake Horsepower
Drawbar Pull, Pounds
Steam Pressures
Trailer Diameter
Miles Per Hour
KEY:
1, From Wheel Diameter, move Horizontally to M.P.H
2, Vertically to Main Curve
3, Horizontally to Steam Pressure
4, Up or down to Diagonal Line having same No. as M.P.H.
5, To Left for D.B.P.
For B.H.P. 1,2,3 then Up

Fig. 7—Chart for Drawbar Pull of Booster

the resistance of the train is available for acceleration. With the booster still more power can be obtained for acceleration and the speed of the train will be increased more rapidly. As the speed increases the train resistance increases and the drawbar pull drops off until finally the drawbar pull just equals the train resistance. Under this condition no more acceleration will take place and the train will run at a constant speed of about 34 miles per hour on level track, as shown by the intersection of the drawbar pull and train resistance curves.

The pull required to start this tonnage on various grades is also plotted on this chart which shows the locomotive can only just start a train of this weight on a 0.3 per cent grade. With the booster the locomotive is able to start it on a 0.5 per cent grade and attain a speed of 17 m.p.h. If the booster is thrown out the speed of the train on this grade will drop back to 6 m.p.h. and if it stops the locomotive would be unable to start again without the aid of the booster.

The great advantage of the booster as shown by this chart is to enable the locomotive to make a grade of 0.7 per cent, while without the booster a train of this weight would stall the locomotive on a grade slightly more than 0.5 per cent. Even with a grade of 0.5 per cent, however, the booster offers the advantage of enabling the train to make a speed of 17

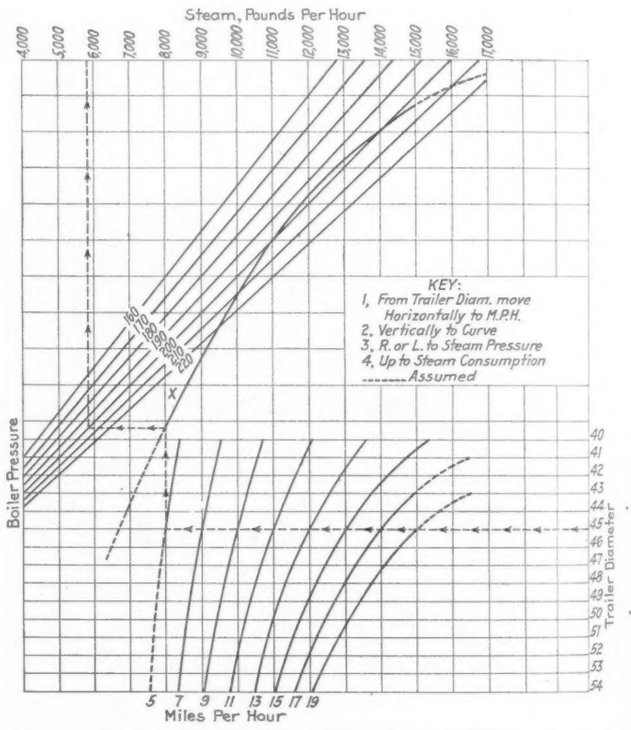


Fig. 8—Chart for Determining Steam Consumption of Booster

m.p.h. instead of only 6 m.p.h., thus saving over 64 per cent of the running time on the grade. With a grade of any appreciable length this saving in running time would be an important item, particularly near congested stations.

In order to enable engineers to predict the results that will be obtained under any given conditions, the curves shown on Fig. 7 have been developed. From these curves the tractive effort for any size wheel and any steam pressures can be determined, as it will be readily understood that these are the only two variables in the formula.

As an example of the use of the chart, assume that the tractive effort for a 45-in. wheel at 200 lb. boiler pressure is desired at speeds at from 5 to 13 miles an hour. The trailer wheel diameter is located at the right of the curves and the 45-in. point is used as the origin. The horizontal line is followed to the left until it crosses the speed curve that is desired, in this case five miles an hour. From the intersection of the horizontal line with this curve a vertical line is followed to the main brake horsepower curve, marked *X*. From this point a horizontal line is followed again

either to the left or right until it crosses the steam pressure curve desired, in this case 200 lb. Then a vertical line is followed, up or down, as the case may be, to the diagonal line in the upper set for the same speed, in this instance to the line marked 5, and moving horizontally from this point to the left, the drawbar pull at the given speed and boiler pressure can be read from the scale at the side. Similarly any desired figure can be obtained and the drawbar pull curve set up for any conditions.

Another factor of interest to engineers is the steam consumption for the booster. To enable this to be readily determined at various speeds, the chart shown in Fig. 8 has been developed. Having determined the wheel diameter and knowing the boiler pressure, the chart is used as follows:

From the point on the lower right hand margin corresponding to the trailer wheel diameter, a horizontal line is followed to the miles-per-hour curve, and thence moving vertically to the curve marked *X*. From this curve a horizontal line is followed to the steam pressure curves, and then moving vertically to the top of the chart the steam consumption in pounds per hour can be read from the scale. It will be seen from the examples given that a complete prediction of the performance of the booster can be made from these curves.

Effect of Tonnage and Speed on Fuel Consumption*

Ton Miles Per Hour Affects Fuel Rate; Economical Tonnage For Various Speeds, Effect of Grade and Car Weight

By J. E. Davenport
Engineer, Dynamometer Tests, New York Central

THIS discussion touches the subject of the economic train load or train speed purely from the standpoint of fuel. Admitting that many times other operating conditions, or costs, or returns, finally settle the question of train load, it is altogether fitting that this association approach the discussion with entire attention directed toward the fuel consumption. The tonnages referred to herein are gross tons of 2,000 lb., not adjusted tons.

A train hauled by a locomotive is a unit made up of two components. The first component, the locomotive, is a machine capable of exerting a maximum drawbar pull at low speeds, and capable of producing a maximum dynamometer horsepower output at some higher speed dependent upon its dimensions (in the case of the modern Mikado this speed is around 30 miles an hour), but in terms of useful work per unit of fuel consumed the maximum efficiency is neither at the maximum dynamometer pull nor the maximum dynamometer horsepower. A modern Mikado type locomotive capable of exerting a dynamometer pull of some 60,000 lb. at speeds below eight or ten miles an hour, and a dynamometer horsepower of some 2,500 at speeds in the neighborhood of 30 miles per hour, shows its maximum efficiency from the fuel standpoint while producing a dynamometer horsepower output in the neighborhood of 1,400, and this output may be produced at any operating speed above approximately 10 miles per hour. The second component, the train, is a machine capable of being hauled most efficiently, as expressed in terms of resistance to hauling, at the lowest possible speeds and in car units of the highest possible weights which can be placed on four-wheel trucks. This statement may need modification when more knowledge is at hand concerning resistance of cars equipped with other than four-wheel trucks. The great number of variables entering into the makeup of the train unit indicates the reason that the question of economic train load is one so difficult of ready solution in all its phases, including the fuel rate. The most efficient fuel performance occurs somewhere between the most efficient locomotive performance and the most efficient train haulage performance.

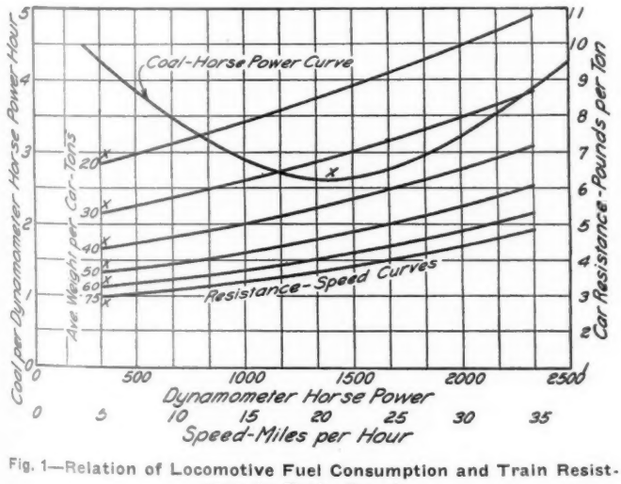


Fig. 1—Relation of Locomotive Fuel Consumption and Train Resistance to Train Speeds

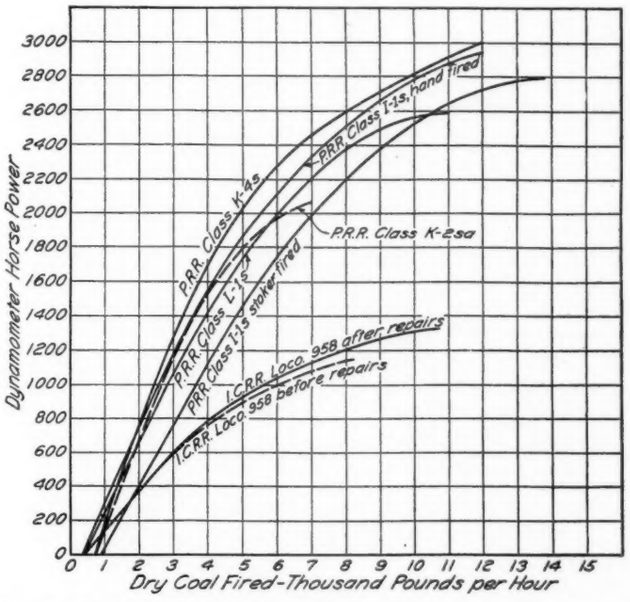

P.R.R. Class K-4s
P.R.R. Class T-1s, hand fired
P.R.R. Class K-2sa
P.R.R. Class L-1s
P.R.R. Class T-1s stoker-fired
I.C.R.R. Loco. 958 after repairs
I.C.R.R. Loco. 958 before repairs
Dynamometer Horse Power
Dry Coal Fired-Thousand Pounds per Hour

Fig. 2—Showing the Increasing Rate of Fuel Consumption in the High Ranges of Horsepower Output

The foregoing roughly expressed generalities are shown

*Abstract of a paper presented before the International Railway Fuel Association, Chicago, May 22, 1922.

graphically in Fig. 1. That portion of each curve marked with an X indicates the most efficient point of operation as related to that component of the train unit.

There are, possibly, many methods of arriving at the relation of load and speed to fuel consumption of which the following is suggested for your consideration. Two commonly accepted principles form the foundation of this method: First, the locomotive component of the train unit develops useful power related definitely to the fuel consumed. Second, the train resists haulage in terms related definitely to the grade, including curvature, speed and weight of the individual cars.

The production of useful power and its relation to fuel consumption is shown in Fig. 2, wherein the dynamometer horsepower developed is plotted against the coal consumed per hour. The curves are plotted from figures developed at the Pennsylvania and University of Illinois locomotive testing plants and represent the most reliable information obtainable on locomotive performance. It will be noted that at the point of maximum horsepower output the coal con-

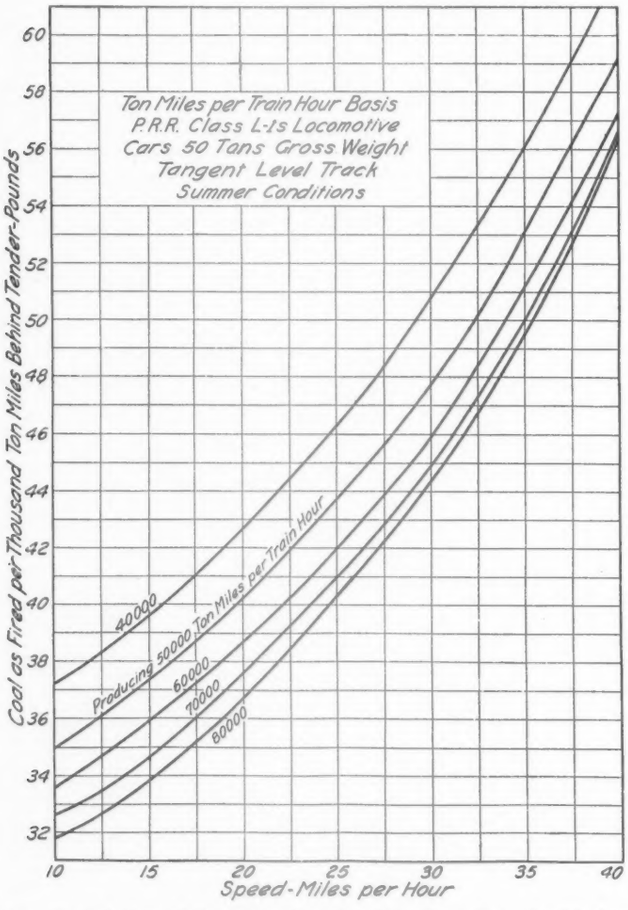


Fig. 3—Relation of Speed to the Ton-Mile Fuel Rate for Various Rates of Ton-Mile Output

sumption increases most rapidly with each unit of power produced. The resistance to haulage is shown in Fig. 1. These curves are reproduced from the University of Illinois studies on Freight Train Resistance. The values shown therein were substantially checked by the writer several years ago, and it is felt under average conditions these curves are entirely acceptable as a measure of car resistance.

Using the Pennsylvania Class L1s Mikado test reported in Bulletin No. 28, Figs. 4, 5, 6, 7 and 8 are submitted, showing in each case the consumption rates while the locomotive is working steam. Fig. 3 shows the relation between speed and coal as fired per thousand ton miles behind the tender with cars of 50 tons gross weight on tangent level track under the development of 40, 50, 60, 70 and 80 thousand ton miles per train hour, indicating a reduced fuel consumption at a set speed with increased ton mile production and a rapidly increasing consumption at a set ton mile production with an increase of speed.

Fig. 4 shows the relation between speed and coal as fired per thousand ton miles behind the tender with cars of 50 ton gross weight for trains of varying weight on tangent level track. These curves indicate that for each weight of train

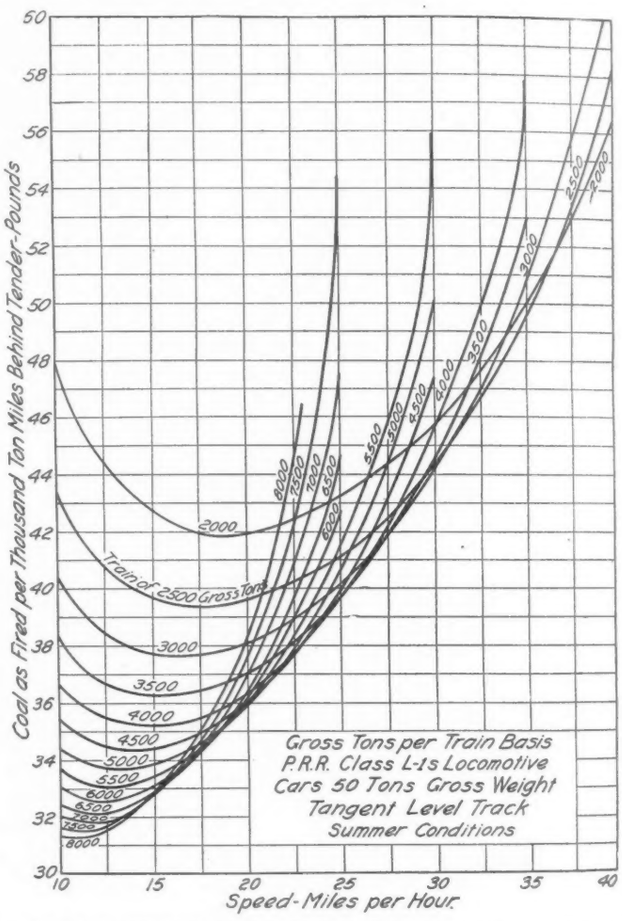


Fig. 4—Speed-Fuel Rate Characteristics of Trains of Various Weights

there is a speed of minimum fuel consumption; the lighter the train the higher this speed. Also they indicate the rapid increase of consumption with increase of speed beyond the point of minimum consumption; the heavier the train the more rapid the increase in consumption. It is interesting to note that the 2,000-ton train and the 8,000-ton train consume the same amount of fuel at 22 miles per hour, but by operating the 8,000-ton train at 11 miles per hour its coal consumption may be reduced to 75 per cent of the minimum possible with the 2,000-ton train.

Fig. 5 shows the relation between train load and coal as fired per thousand ton miles behind the tender with cars of 50 tons gross weight, operating at various speeds on tangent level track. These curves locate 20 miles per hour as the most economical speed for a train of from 2,000 tons to 2,500 tons, 15 miles per hour for trains from 2,500 to 6,000 tons and 10 miles per hour for trains from 6,000 to 8,000 tons, these economic speeds of course would be altered slightly had other individual speed lines been shown. These curves indicate that for 10 miles per hour operation the train tonnage should be over 8,000 tons for minimum consumption; for 15 miles per hour operation, between 7,000 and 8,000 tons; for

20 miles per hour operation, 4,500 to 5,500 tons; for 25 miles per hour operation, around 4,000 tons; for 30 miles per hour operation, slightly under 3,000 tons; for 35 miles per hour operation, slightly under 2,500 tons; and for 40 miles per hour operation, something less than 2,000 tons.

Fig. 6 shows the relation between speed and coal as fired per thousand ton miles behind the tender with 40 cars of 50 tons gross weight (2,000 ton train) on tangent level track and tangent grades of .1 per cent, .2 per cent, .3 per cent, .5 per cent, .8 per cent and 1 per cent. These curves emphasize the effect of speed and grade on fuel consumption and

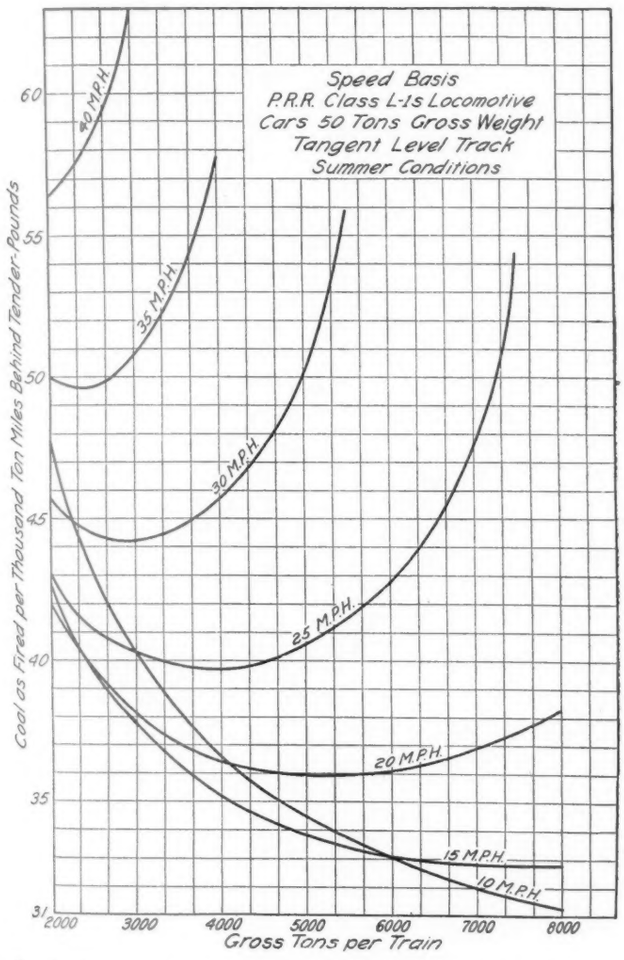


Fig. 5—Curves Showing the Economical Tonnages for Various Operating Speeds

indicate that the heavier the grade, the less the speed at which minimum fuel consumption may be expected. For example, the minimum rate on a 1 per cent grade is 199 lb. per thousand ton miles at 8 miles per hour, and on level track 42 lb. at 18 miles per hour. Also it requires 10 per cent more fuel at 14 miles per hour on a 1 per cent grade than at 8 miles per hour.

The foregoing charts having dealt with cars of 50 tons gross weight, a figure close to the average for eastbound loads on trunk line roads, Fig. 7 is produced to indicate the relation between speed and coal as fired per thousand ton miles behind the tender for the empty car return movement, cars of 20 tons gross weight, on tangent level track. These curves indicate the same relation as with the loaded cars: a minimum consumption for each train weight at some definite speed, the lighter the train the higher the speed. They also indicate that for operating speeds between 10 and 20 miles per hour a train of 150 cars shows the most economical performance; between 20 and 24 miles per hour, trains of 125 cars; between 24 and 30 miles, trains of 100 cars; between 30 and 36 miles, trains of 75 cars, and between 36 and 40 miles per hour, trains of 50 cars. Comparing the minimum consumption of 2,000 ton trains in Figs. 5 and 8, it is noted that the empty car train requires 60 per cent more fuel than the loaded train. This indicates the importance of the empty car movement in any fuel economy program.

Practical Application

Using recent dynamometer car tests with a 4-8-2 type locomotive, computing the train resistance established for level tangent track and relating this figure to the actual average dynamometer pull recorded, there is located what might be termed the equivalent grade for this territory. In Fig. 8 there is plotted the relation between the coal as fired per thousand ton miles behind the tender and speed for trains of cars of 35 tons weight, and trains of cars of 55 tons weight, both sets of curves making use of the equivalent grade figure of .06 per cent. The trains shown in the upper group, i. e., of 35 ton car weight, represent trains falling in the fast

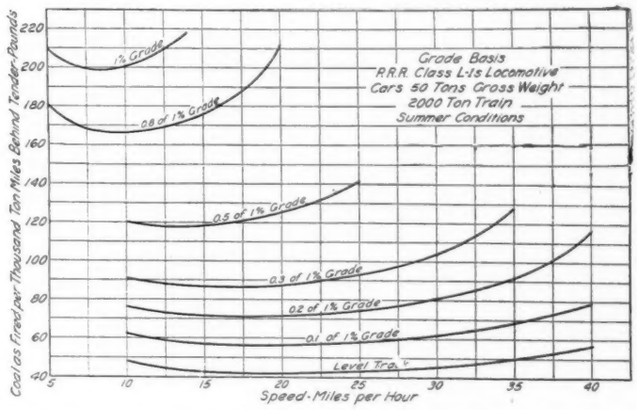


Fig. 6—How Grade Affects the Relation Between Speed and Unit Fuel Consumption

freight service and trains in the lower group, i. e., of 55 ton car weight, represent trains falling in the slow freight service.

Analyzing the operation from the curves shown in Fig. 8 for the period of 1921, covering the five summer months, in the fast freight service an average load of 2,675 tons was handled at an average operating speed of 19½ miles per hour, and in the slow freight service an average load of 5,750 tons was handled at an operating speed of 15 miles per hour. This fast freight service from the foregoing analysis shows the coal consumption of 76.6 lb. per thousand ton miles and the slow freight service a coal consumption of 54 lb. per thousand ton miles, showing an increase of 41 per cent in fuel for the fast freight service over the slow freight. A similar check of a different class of power in another territory, indicating an equivalent grade of .085 per cent, shows a coal consumption of 84 lb. per thousand ton miles in fast freight service and 63 lb. in slow freight, or an increase of 33 per cent in fuel in the handling of fast freights, which increase results from the combination of a higher speed, lighter train load and lighter individual car weight.

Many errors are made by the yard forces in computing the size of the individual train in both fast and slow freight trains. These errors in numerous cases on the slow freight side amount to as high as 20 per cent in the tonnage ordered and on the fast freight side running at times to 15 per cent. When errors of this nature produce a train heavier than is ordered the resultant will produce a more economical coal consumption since the operating speed in this service is from 14 to 20 miles per hour. However, when the error results in an underload of from 10 to 15 per cent the increase in the operating speed of this particular unit will result in an in-

creased coal consumption as high as 10 per cent or 12 per cent.

Conclusions

The method outlined herein for ascertaining the relation between train load, speed and fuel consumption is suggested as possible for practical application for use during that portion of freight train movement while the locomotive is using steam. The fuel consumption during that portion of the run while the locomotive is drifting and during the delay periods must be computed in a different manner, and from the locomotive test plant results will amount to from 300 to 900 lb. per hour, depending upon the class of locomotive and method of firing. It is evident that local operating conditions will in each case govern the ratio of the portions of the run during which the locomotive is using steam and hauling the train and during which the locomotive will be

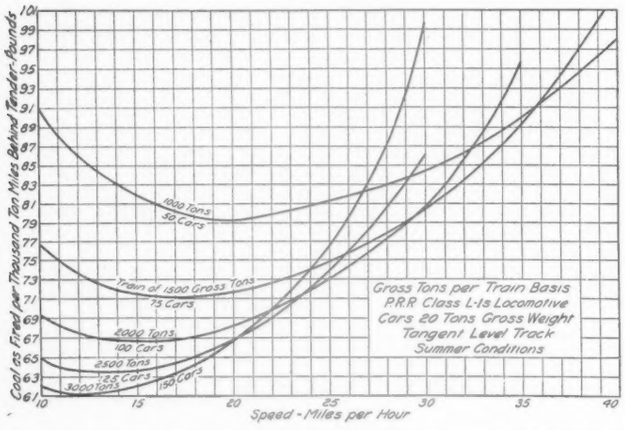

Coal as Fired per Thousand Ton Miles Behind Tender-Pounds
Speed - Miles per Hour
1000 Tons 50 Cars
Train of 1500 Gross Tons 75 Cars
2000 Tons 100 Cars
2500 Tons 125 Cars
3000 Tons 150 Cars
Gross Tons per Train Basis
P.R.R. Class L-1s Locomotive
Cars 20 Tons Gross Weight
Tangent Level Track
Summer Conditions

Fig. 7—Speed-Fuel Rate Characteristics of Trains of Light Weight Cars

consuming coal at this lesser figure, or in other words the relation between train load, speed and fuel consumption varies in each territory and each direction and can best be solved by local studies. Assuming the foregoing proposed method as containing a fair amount of merit, the conclusion is reached that for each weight train in each direction there will be a definite speed at which the minimum coal consumption will result, and with speeds either higher or lower than this definite speed there will be an increase in coal consumption. Generally speaking the handling of heavier cars and heavier trains and operation at moderate speeds will greatly assist in reducing the fuel bills.

Discussion

The following is an abstract of a written discussion presented by E. E. Ramey (B. & O.):

As the subject indicates, the effect of train load and running speed on unit fuel consumption alone has been considered in the paper, and the conclusions are given in pounds of coal per 1,000 gross ton-miles. It is also fairly general practice to measure the wage performance in freight service on the basis of some such unit as gross ton-miles per hour of crew time or wage cost of train and engine crews per 1,000 gross ton-miles, and it is not inappropriate to attempt a combination of the fuel and wage costs, which are the controlling factors in the cost of producing ton mileage, and to use the combined fuel and wage cost as an indicator of

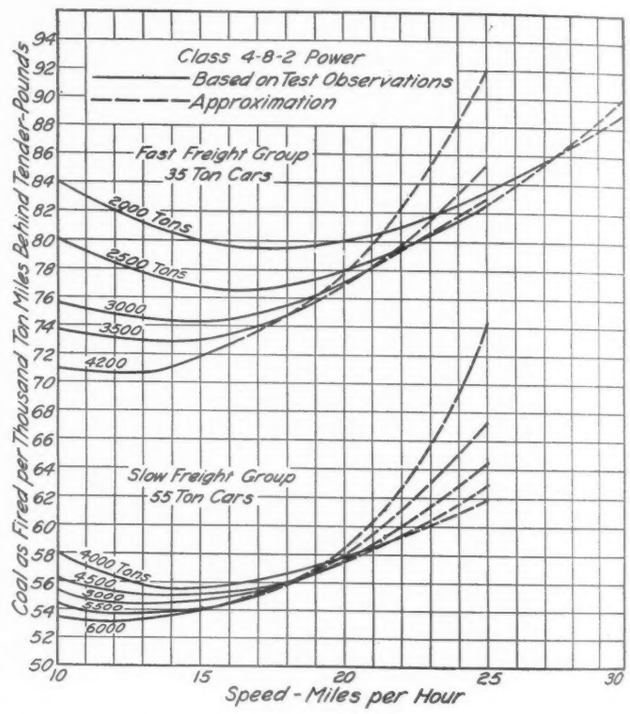


Fig. 8—Application to a Typical Operation on .06 Per Cent Equivalent Grade

the trend of the actual unit cost of the movement of traffic.

In practice this may be done currently by the compilation of a running daily and cumulative record of the performance of similar trains and groups of trains arranged as the particular operating conditions may render desirable. Comparison of the performance day by day of specific engine runs or operating divisions with good previous performances and with properly established standard performances will indicate the trend of the unit expense of moving the traffic.

To illustrate the position here taken, Table I has been

TABLE I—COMBINED COST OF FUEL AND WAGES PER 1,000 Gross Ton-Miles for Trains of 2,000 tons to 6,000 Tons

Crew time, hours	Running Time, hours	Running Speed, m. p. h.	2,000-ton train Coal	2,000-ton train Wages	2,000-ton train Total	3,000-ton train Coal	3,000-ton train Wages	3,000-ton train Total	4,000-ton train Coal	4,000-ton train Wages	4,000-ton train Total	5,000-ton train Coal	5,000-ton train Wages	5,000-ton train Total	6,000-ton train Coal	6,000-ton train Wages	6,000-ton train Total
13.0	10.0	10	14.8	26.4	41.2	12.0	17.6	29.6	10.8	13.2	24.0	9.7	10.6	20.3	9.3	8.8	18.1
12.1	9.1	11	14.4	24.2	38.6	11.7	16.1	27.8	10.4	12.1	22.5	9.6	9.7	19.3	9.2	8.1	17.3
11.3	8.3	12	14.0	22.1	36.1	11.6	14.7	26.3	10.3	11.1	21.4	9.6	8.9	18.5	9.1	7.4	16.5
10.7	7.7	13	13.8	20.6	34.4	11.4	13.7	25.1	10.2	10.3	20.5	9.5	8.3	17.8	9.2	6.9	16.1
10.2	7.2	14	13.6	19.3	32.9	11.4	12.9	24.3	10.2	9.7	19.9	9.5	7.7	17.2	9.2	6.4	15.6
9.7	6.7	15	13.5	18.0	31.5	11.3	12.0	23.3	10.2	9.0	19.2	9.6	7.2	16.8	9.3	6.0	15.5
9.3	6.3	16	13.4	16.9	30.3	11.3	11.0	22.3	10.2	8.5	18.7	9.6	6.8	16.4	9.4	5.7	15.1
8.9	5.9	17	13.4	16.0	29.4	11.3	10.7	22.0	10.3	8.0	18.3	9.7	6.4	16.1	9.5	5.3	14.8
8.6	5.6	18	13.3	15.2	28.5	11.3	10.1	21.4	10.3	7.6	17.9	9.8	6.1	15.9	9.6	5.1	14.7
8.3	5.3	19	13.3	14.4	27.7	11.4	9.6	21.0	10.4	7.2	17.6	9.9	5.8	15.7	9.8	4.8	14.6
8.0	5.0	20	13.3	13.7	27.0	11.4	9.1	20.5	10.5	6.8	17.3	10.1	5.5	15.6	10.0	4.6	14.6
7.8	4.8	21	13.4	13.7	27.1	11.5	9.1	20.6	10.6	6.8	17.4	10.3	5.5	15.6	10.3	4.6	14.9
7.6	4.6	22	13.4	13.7	27.1	11.6	9.1	20.7	10.7	6.8	17.5	10.5	5.5	16.0	10.6	4.6	15.2
7.4	4.4	23	13.5	13.7	27.2	11.7	9.1	20.8	10.9	6.8	17.7	10.7	5.5	16.2	10.9	4.6	15.5
7.2	4.2	24	13.5	13.7	27.2	11.8	9.1	20.9	11.1	6.8	17.9	11.0	5.5	16.5	11.2	4.6	15.8
7.0	4.0	25	13.6	13.7	27.3	12.0	9.1	21.1	11.3	6.8	18.1	11.3	5.5	16.8	11.7	4.6	16.3
6.6	3.6	28	13.9	13.7	27.6	12.5	9.1	21.6	12.1	6.8	18.9	12.4	5.5	17.9	13.5	4.6	18.1
6.4	3.4	30	14.3	13.7	28.0	12.9	9.1	22.0	12.8	6.8	19.6	13.6	5.5	19.1	....	....	....
5.9	2.9	35	15.3	13.7	29.0	14.7	9.1	23.8	....	....	....	....	....	....	....	....	....
5.5	2.5	40	16.9	13.7	30.6	....	....	....	....	....	....	....	....	....	....	....	....

prepared on the basis of Fig. 4 of Mr. Davenport's paper. In addition to these specified conditions, the following assumptions have been made to incorporate the wage factor:

(a) Locomotive run of 100 miles for Mikado locomotive.
(b) Terminal and road delays amounting to a total of three hours per trip.
(c) Train and engine crew wages of $27.32 for eight hours or 100 miles with overtime at the rates generally in effect.
(d) Cost of coal on tenders, $5.00 per ton of 2,000 lb.
(e) Consumption of coal during the three hours of delay at the rate of 750 lb. per hour.
(f) Crew time used in estimating the wage and fuel expense.

The general indication of the table for the conditions assumed, is that the wage factor predominates to the extent that the running speed for the lowest unit cost of wages and fuel combined is practically identical with the running speed for the lowest unit cost of wages alone, i.e. 20 miles per hour.

The running speeds for the lowest unit cost of fuel under the specified conditions vary from 19 to 20 miles an hour for a train of 2,000 tons to 12 miles an hour for a train of 6,000 tons. This would indicate a material variation for the heavier trains between the running speed of lowest unit fuel cost and that of lowest unit cost of wages and fuel.

In a general way it would appear that for the trains of 3,000 gross tons or more, reduction of delays will cause the running speed of lowest unit wage cost to approach the running speed of lowest unit fuel cost, resulting in a cumulative lowering of the combined unit cost. It appears that for the trains of less than 3,000 the running speed for the lowest possible combined unit cost is around 20 miles per hour. These conclusions are based upon the condition of tangent level track.

Alloy Steel Reduces Weight of Locomotive Parts

Rods, Axles and Crank Pins Made Lighter and Dynamic Augment Reduced on Union Pacific No. 7000 by Using Carbon Vanadium Steel

By R. J. Finch
American Locomotive Company, Schenectady, N. Y.

IN the 4-8-2 type experimental locomotive No. 7000 recently built by the American Locomotive Company at its Schenectady plant for the Union Pacific, carbon-vanadium steel was used in a number of the principal working parts, these parts being as follows: main and side rods, driving axles, trailing axles, crank pins and piston rods.

In using this high-grade steel in this locomotive, it was thought best both by the railroad company and the locomotive builders to take advantage of the better qualities of this steel partly to secure lighter parts by allowing higher stresses and partly to give an additional factor of safety. Therefore, in designing these parts the stresses were kept within a max-

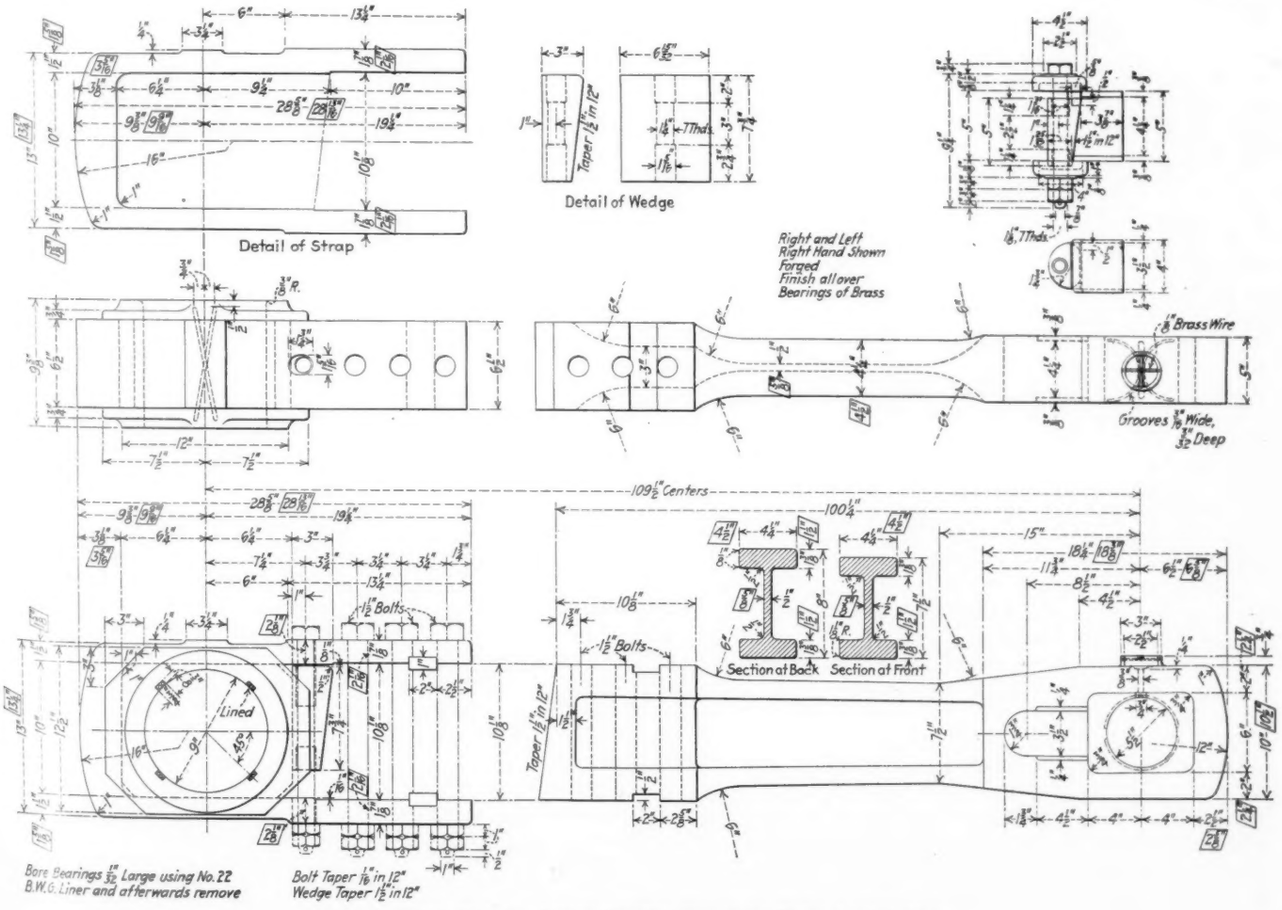


Fig. 1—Main Rod for Union Pacific Mountain Type Locomotive

imum of 15 per cent above the limit of stresses ordinarily used when the same parts are made of carbon steel, whereas the elastic limit of the carbon-vanadium steel used exceeded the elastic limit of carbon steel by more than 50 per cent.

It should be borne in mind that an increase in stress of 15 per cent for the carbon-vanadium steel over the carbon steel does not mean a saving in weight of 15 per cent, inasmuch as it is necessary to maintain ample bearing areas for the several crank pins and knuckle joints, which bearing areas are independent of the material used.

The purpose of this article is to show not only what was done in saving weight, but also just what was done in lessening the blow of the different wheels upon the rails (commonly known as dynamic augment). This saving in weight and decrease in the blow delivered to the rail enables the locomotive to haul more tonnage, which in turn means saving in coal and water, or a saving in money.

This saving is again extended to the upkeep of track and roadbed as well as upkeep in the machine itself by the lessening of the pounds. While the amount of saving in weight may seem trivial, yet if the saving in dollars and cents be considered for all these items, it would be found to be surprisingly high.

Fig. 1 shows a detail of the main rods and Fig. 2 of the side rods, the enclosed dimensions being about what would have been required had the parts been made of carbon steel. Fig. 3 shows the piston rod, which was made 4¾ in. hollow bored instead of 5 in. solid, to maintain areas for keys and crosshead and piston fits. The saving in weight in the crank pins and axles has been accomplished entirely by hollow

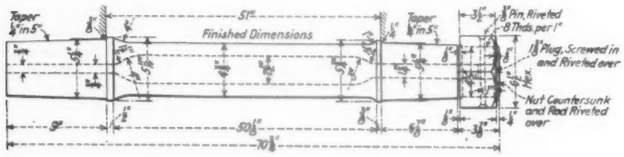


Fig. 3—Details of Hollow Piston Rod

boring, it being necessary to maintain ample bearing area for the journals. No saving was made in the weight of the front crank pin. The main crank pin was hollow bored 3½ in. in diameter, the hole being swedged down to 1¼ in. for a distance of 6 in. from the outer end. The intermediate and back crank pins were drilled out with a hole 2 in. in diameter extending from the inside face to within 1½ in. of the shoulder for the crank-pin collar. The driving and trailing axles were hollow bored 3 in. in diameter.

Table I shows the weight of the different parts; one column shows the actual weight of the carbon-vanadium parts, another column shows what the same parts would have weighed if made of carbon steel, while still another column shows the weight saved for each part, and the last column, the total saved per locomotive. It will be noted that the aggregate saving in these parts was 1,490 lb.

Of the 94 lb. saved in one main rod, 42 lb. was in the reciprocating part of the rod. This, added to the 99 lb. saved in one piston rod, gives a saving in reciprocating weight for each side of 141 lb. The driving wheels of this locomotive were balanced in accordance with the Master Mechanic's formula of balancing 50 per cent of the reciprocating weight. Fifty per cent of this 141 lb. divided among four wheels gives a saving in reciprocating weight of 18 lb. per wheel.

Table II shows the reciprocating weight of 18 lb. per wheel, to which is added the saving in the revolving weight for each wheel due to the lighter main and side rods and crank pins. It will be noted from this table that there was a saving in balance at the crank pin of 29 lb. for each front wheel, 66 lb. for each intermediate, 171 lb. for each main and 38 lb. for each back wheel. The centers of gravity of

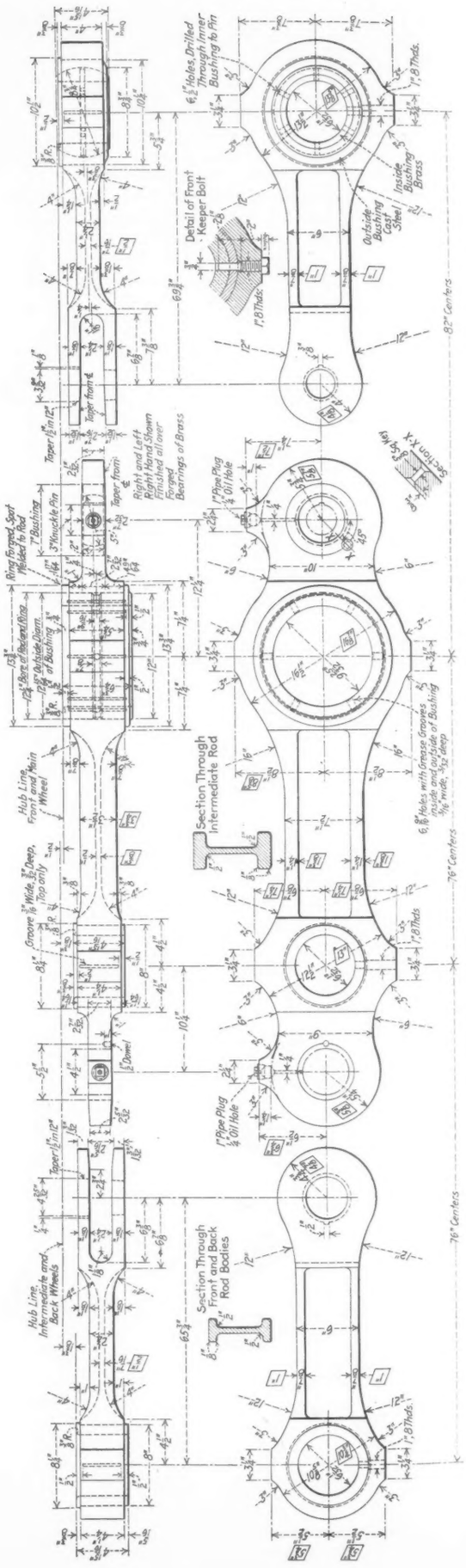

Section Through Intermediate Rod
Section Through Front and Back Rod Bodies
Hub Line, Front and Main Wheel
Hub Line, Intermediate and Back Wheels
Detail of Front Keeper Bolt
Inside Bushing Brass
Outside Bushing Case Steel
1" Pipe Plug ¼ Oil Hole
Right and Left Right Hand Shown All over Forged Bearings of Brass
Ring Forged Soft Welded to Rod
1" Bushing
3" Knuckle Pin
Groove ⅛ Wide, ⅜ Deep, Top only
1" Dowel
Taper 1" in 12"
Taper from ℄
Taper ¾" in 12"
6 ⅜" Holes with Grease Grooves Inside and Outside of Bushing ⅜ Wide, ⅜ Deep
6 ⅜" Holes, Drilled Through Inner Bushing to Fit
1" Thds.
8" Centers
76" Centers
SECTION X-X

Fig. 2—Back, Intermediate and Front Side Rods

the balances, however, were farther out than crank pin radius, and the actual savings in weight were 15.6 for front, 34 for intermediate, 101.8 for main and 19.6 lb. for the back wheels. Twice the sum of these four savings, or 342 lb., is what was saved in the wheels themselves. This, added to the 1,490 lb. given in Table I, or 1,832 lb., is what was

TABLE I.—WEIGHT OF PARTS.

Name of part	Actual weight of carbon-vanadium parts, lb.	Estimated weight of carbon steel parts, lb.	Saving in weight per piece, lb.	Saving in weight per engine, lb.
Front Crank Pin	102	102	...	...
Main Crank Pin	472	532	60	120
Inter Crank Pin	120	130	10	20
Back Crank Pin	120	130	10	20
Piston Rod	332	431	99	198
Main Rod	1206	1300	94	188
Side Rods, Front	328	353	25	50
Side Rods, Inter	728	783	55	110
Side Rods, Back	270	290	20	40
Front Driving Axle	1383	1520	137	137
Main Driving Axle	2081	2220	139	139
Inter Driving Axle	1406	1545	139	139
Back Driving Axle	1406	1545	139	139
Trailing Truck Axle	1635	1825	190	190
			Total	1490

saved in the weight of the locomotive by the use of this carbon-vanadium steel.

The bottom line of Table II shows just what was saved in each wheel in the blow, or dynamic augment. The amount added to the counterbalance to neutralize a portion of the longitudinal inertia forces due to the reciprocating parts is unbalanced in a vertical direction, and these figures are the additional blow which would have been caused by each wheel if this 18 lb. of additional weight had been balanced in each wheel. This figure for the dynamic augment, or vertical blow on the rail, is based on a speed of 73 miles per hour, or a speed in miles per hour equal to the diameter of the drivers in inches. The blow varies directly

TABLE II. SAVING IN COUNTERBALANCE WEIGHT.

Saving in Balance at Pin, lb.	Back	Inter.	Main	Front
Reciprocating	18	18	18	18
Revolving weight of Main Rod	..	..	52	..
Revolving weight of Side Rods	10	38	41	11
Revolving weight of Crank Pins	10	10	60	0
Total at Pin	38	66	171	29
Total at Counterbalance	19.60	34	101.80	15.60
Dynamic Augment at Dia. Speed, lb.	806	806	806	806

as the square of the speed, and if blows are wanted for less or greater speeds, they can readily be calculated. The total additional blow per side would be four times 806 lb., or 3,224 lb. The dynamic augment of the locomotive as built is 45,230 lb. per side at 73 miles an hour.

The balances on the one side being at 90 deg. to the balances on the opposite side, the maximum combined effect of the blow on the track, or on a bridge, would be when both balances were down, the one balance being at a 45 deg. angle forward of the perpendicular, and the other 45 deg. back of the perpendicular. This combined blow at diameter speed would be $2 \times 3{,}224 \times .707 = 4{,}560$ lb., .707 being the cosine of the 45 deg. angle. It is then seen that not only a saving in weight in the engine of 1,832 lb. was accomplished, but greater still, a continuous blow or pound of 3,224 lb. per side (4,560 lb. total) was saved.

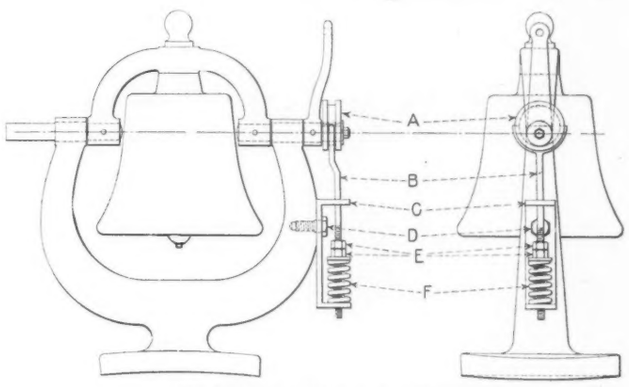
THE PENNSYLVANIA RAILROAD reports that its surprise checking, conducted during the month of July, in the Eastern Region, shows that efficiency in train operation has not been impaired, in the slightest degree, by the shopmen's strike. The records show a perfect performance in more than 99.9 per cent of the cases. A total of 33,807 tests were made, and but 38 failures were recorded. Eight divisions had absolutely perfect scores. They were the Philadelphia, Cumberland Valley, Cresson, Trenton, Baltimore, Norfolk, Elmira and Schuylkill Divisions.

Friction Stop for Locomotive Bells

By Warren Ichler

EVERY mechanical engineer is familiar with the complaints of enginemen because of the turning over of locomotive bells by the various mechanical ringers now in general use. In an effort to prevent this nuisance various mechanical officers have resorted to pieces of hose attached to the top of the bell yoke; to ropes wrapped around the hand crank and bell yoke and various other makeshift appliances which have served to correct the turning over of the bell but are very unsightly and at best mere temporary expedients.

The effort has been to make a positive stop for the bell yoke, and while it is admittedly desirable to have a positive



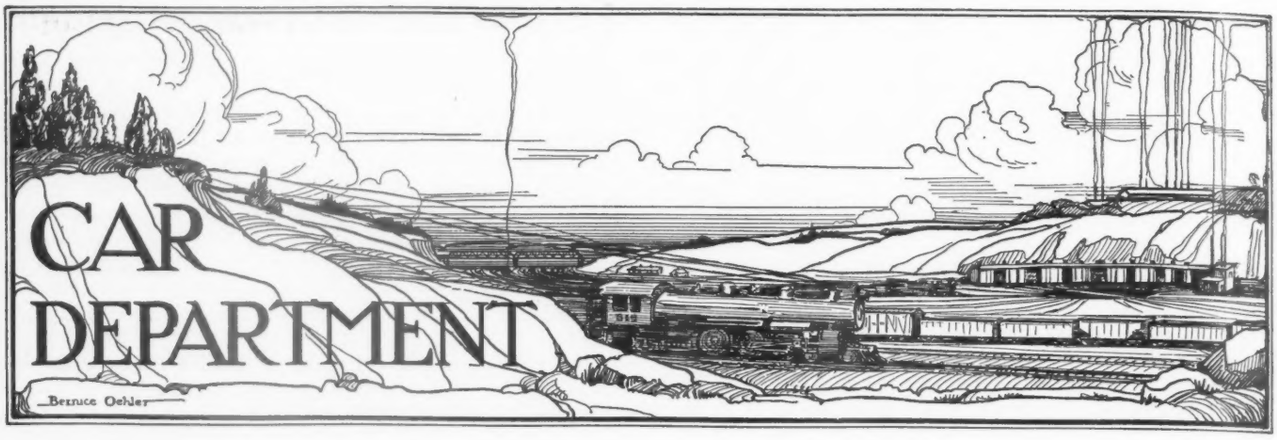
Method of Applying the Stop

stop for extreme cases, a more desirable device would be one which would bring the bell to a gradual stop without throwing undue torsional stresses on the trunnion pins and shearing stresses on the rivets through these pins. Another troublesome feature of any positive stop is the fact that the downward swing of the bell is accelerated in greater or less degree depending on the character of the device used, and consequently the strain on the supporting pins and rivets becomes greater and greater as the acceleration increases.

In an effort to solve this problem, the writer made the device shown in the drawing and the results were so much better than had been expected that this simple mechanism is here offered for the benefit of other mechanical officers.

As will be seen from the sketch, the device consists essentially of an eccentric *A*, a push-rod *B*, yoke *C*, cap-screw *D*, coil-spring *F* and adjusting nuts *E*. The eccentric is mounted on the trunnion pin of the bell on the left or hand-crank side, the pin being made long enough for this purpose. The mounting may be secured by a key or by a hub and set-screw, and the eccentric is placed with the radius of eccentricity opposite the clapper when the bell is at rest or at its extreme low point. Any movement of the bell from this position causes the eccentric to depress the forked push-rod against the resistance of the string; this causes the push-rod to act as a friction brake on the eccentric. Of course, the frictional resistance of the push-rod increases directly with the upward stroke of the bell and decreases directly with the downward stroke.

In practice this device has worked splendidly and with practically no attention except an occasional adjustment to suit individual preferences regarding the arc of the bell stroke. The eccentric is usually made with a ¾-in. radius of eccentricity, the push-rod of ⅝-in. round, the yoke of ⅜-in. by 2-in. bar and the spring of ⅛-in. brass wire wound on a ¾-in. mandrel. The only part requiring machining is the eccentric and it is believed that a cast eccentric could be successfully used.



Interesting Examples of Passenger Car Development

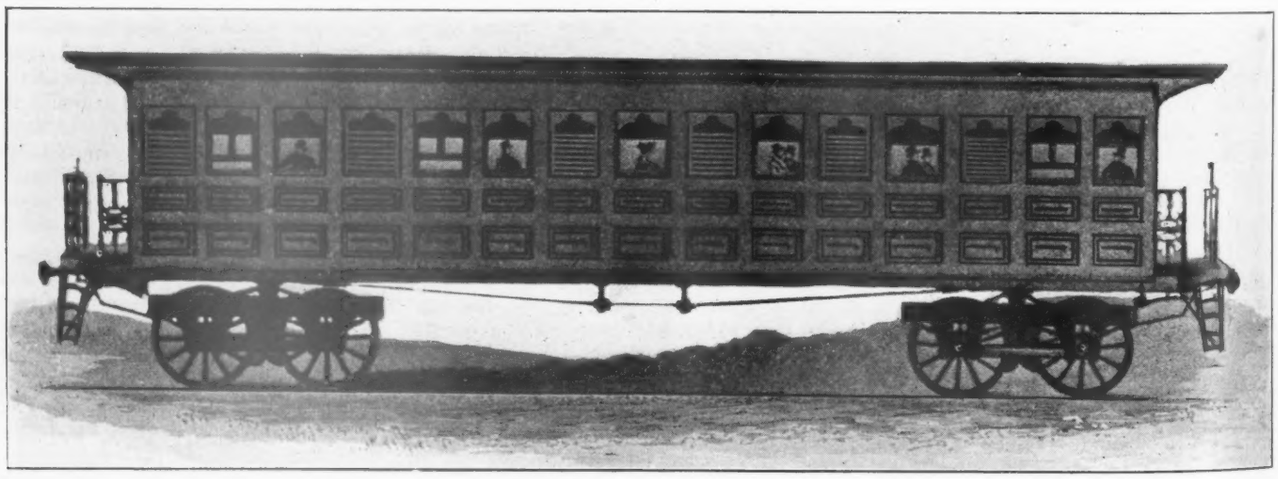
Progress in Design from 1836 to Date as Exemplified by One of the Oldest Car Shops

THOSE who are familiar with modern railroad equipment oftentimes fail to realize the remarkable progress that has taken place in the short period of 90 years since the first locomotive was introduced in this country. The history of railroad development is a fascinating subject, and it may be of interest to readers of the *Railway Mechanical Engineer* to review briefly the evolution of the modern passenger coach as exemplified in the work of a car building plant established when railroads were in their infancy.

One of the oldest and best known of the car shops in the east is the long-established Harlan and Hollingsworth Corporation at Wilmington, Del., now owned and operated by the Bethlehem Shipbuilding Corporation, Ltd., as its Harlan plant. This plant had its beginning in 1836 when the firm of Betts & Pusey was organized for the purpose of building railway cars. Its history has been closely interwoven with the development of car building since that early date, and the plant takes considerable pride in this intimate association with the industry practically from its beginning. It is interesting to note that a number of the present employees date their connection with the Harlan plant back to more than fifty years ago.

The first car shop occupied by Betts & Pusey consisted of a three-story, plain brick building 65 ft. long and 45 ft. deep. In the basement of this building, the blacksmith fires were located and the iron was forged for the trucks and other parts. On the upper three floors the business of car building was conducted in all its branches.

A few woodworking tools in vogue in that day together with the work benches, etc., were distributed about the second floor; while the upholstery room, the cabinet shop, the trimming room and other divisions of the business occupied the remaining space not required by the erection of the car bodies. The cars, when completed, were lowered bodily through large traps in the floor, and landed on the first story, where, after receiving their running gear, they were painted and varnished in readiness for delivery.

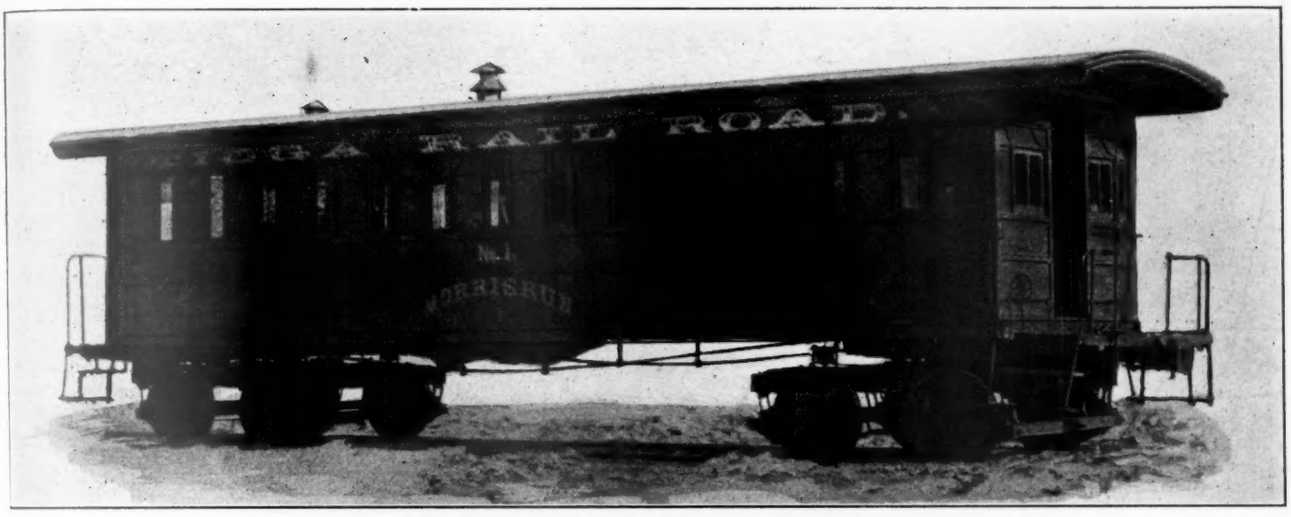


Type of Passenger Car Built in 1836

Due to the lack of connections in the early days between the existing railroads, the matter of making deliveries of finished cars, especially to lines any considerable distance from the car shop, presented an important and difficult prob-

lem. It was at times necessary to draw the new cars to their destination over improvised shifting wooden tracks. In the case of cars built for southern roads, these were shipped completely assembled on vessels to the seaport town nearest their point of destination. Sometimes cars were made in sections for shipment like present day knocked-down furniture, and were assembled on arriving at the road for which they had been built.

These physical limitations of the early car builders in making deliveries naturally limited the scope of territory over which it was advisable to take orders, and Betts & Pusey, therefore, confined their activities principally to roads whose proximity to Wilmington permitted easy conveyance of the cars from the shop to the tracks.



Morris Run No. 1 Built in 1840 for the Tioga Railroad

Interior of the Tioga Car

A review of the various types of cars built at the Harlan plant from its beginning to the present time takes in practically every forward step in the development of the modern steel passenger car, and shows most strikingly the transition from one period of design to the next. An interesting fact is that the first form of car, which resembled the old stage coach in design, was used for only a very short time, being quickly superseded by larger and stronger cars very much of the same general type as used today. This advance in design was followed in turn by the lavishly finished car, profusely decorated, polished and ornamented inside and out, which has recently given way to the simple, dignified, safe and comfortable all-steel coach.

The first cars were built largely of wood; truck frames and underframes were wood, with a very restricted use of iron. As car sizes increased, the use of iron became more general in all parts, and gradually increased until the advent of the all-steel coach where wood is used only in window frames, trimmings, etc.

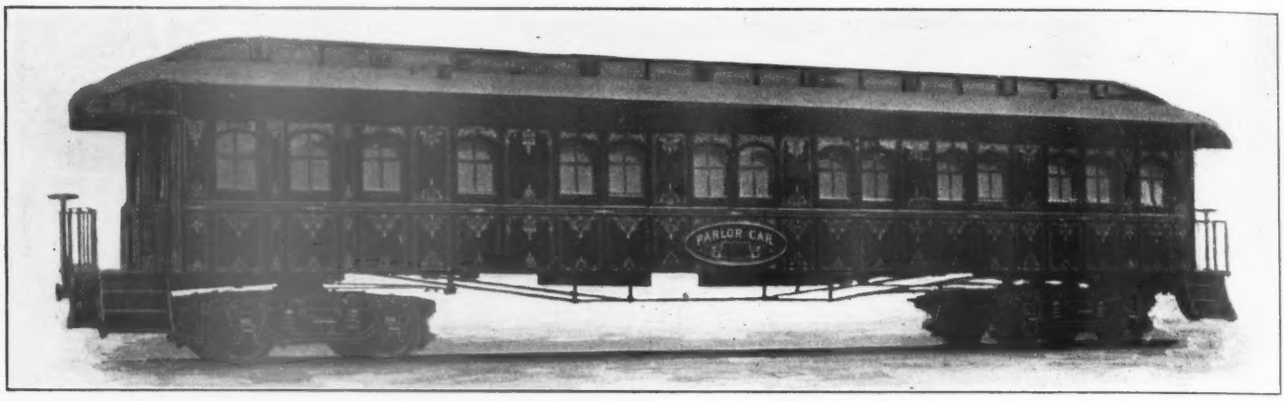
The first railroad cars built at the Harlan plant were contemporary with the beginning of the railroad industry of the United States. In 1830 there were only 23 miles of railroad in operation in the United States, and it was on August 9, 1831, that there was run what deserves to be called the first passenger train in America. This was the train hauled from Albany to Schenectady on the Mohawk and Hudson railroad, by the famous De Witt Clinton locomotive, and was made up of cars of the old stage-coach construction.

In the design of cars built at the Harlan plant in 1836, five years after the operation of the first railroad train, as can be seen from the accompanying illustrations, the stage-coach type had been abandoned and the end platform is seen to have been adopted, thus setting a style that has become standard in American car building.

Within four years from the date of its establishment, or in 1840, the firm, which was then known as Betts, Pusey and Harlan, built what was considered the best type of coach designed up to that time and which was in reality the first of the modern type of passenger car. This car was built for the Tioga Railroad, which is now operated by the Erie Railroad and extends from the Pennsylvania-New York state line to Morris Run, Pa. This car, known among railroad men as the "Tioga Car" and named the "Morris Run No. 1," obtained considerable prominence through being chosen by the Harlan and Hollingsworth Corporation to be placed in exhibition at the Chicago Exposition of Railway Appliances, held in 1883, as an illustration of the durability of passenger coaches when constructed of the best materials,

as well as to furnish a comparison between the earliest and later types of cars. This car was put in service in September, 1840, and ran regularly until August, 1883. Its cost was $2,040.

The dimensions and details of the Tioga car, in comparison with the modern passenger car, show to what an extent the art of car building has progressed. In length this car



Centennial Parlor Car Built at Harlan Plant in 1876

was 32 ft. over frame, its width was 8 ft. 6 in. over frame, while its height from floor to ceiling was 6 ft. 4 in., with no raised roof. It was built with continuous framing, solid bracing, double uprights, stationary sash and Venetian blinds. The order for this car specified "One first-class passenger car" to be finished in every respect in a "highly modern" manner, with all the latest improvements. It was styled in the contract "An Eight-wheeled Passenger and Ladies' Accommodation Car," and was intended to excel anything of the kind then running in the country. Although at this late date we can scarcely realize the actual state of affairs as then existed in railroading owing to the great improvements that have since taken place, it is fair to assume that the Morris Run No. 1 when it left the shop equaled, and perhaps excelled, in beauty of finish, in comforts and arrangements, any other car then in operation. There is no doubt, however, as to the thoroughness of the construction and the quality of the materials used in this early car, as is attested by its operating life of nearly half a century.

This car was a total departure from what had previously been used in this country and abroad, and more nearly approaches present day practice than any car built up to that time. Among other features it contained a "hood" consisting of an extension of the roofing, which extended beyond the body for protection to passengers when alighting. The roof, however, was not raised, the upper boarding being laid on flat from end to end.

The windows of this car had the peculiarity of being glazed in solid without any sash, and the wooden panels forming the sides of the car were made to open by sliding the lower half up inside the upper half. These panel openings were very narrow and were intended for ventilation rather than for sight. This arrangement gave the car a very odd appearance on the outside.

The building of a car like the Morris Run No. 1 was quite an achievement, when it is considered how crude the available tools were for working the iron and wood. The equipment of the original Harlan Plant shop, about the year 1836, consisted of a circular saw, a Daniels planer (which could plane but half a car stringer at a time, the piece being then taken out and the other end put in), a very limited assortment of other primitive appliances of a like degree of adaptability, and a few work benches for the carpenters.

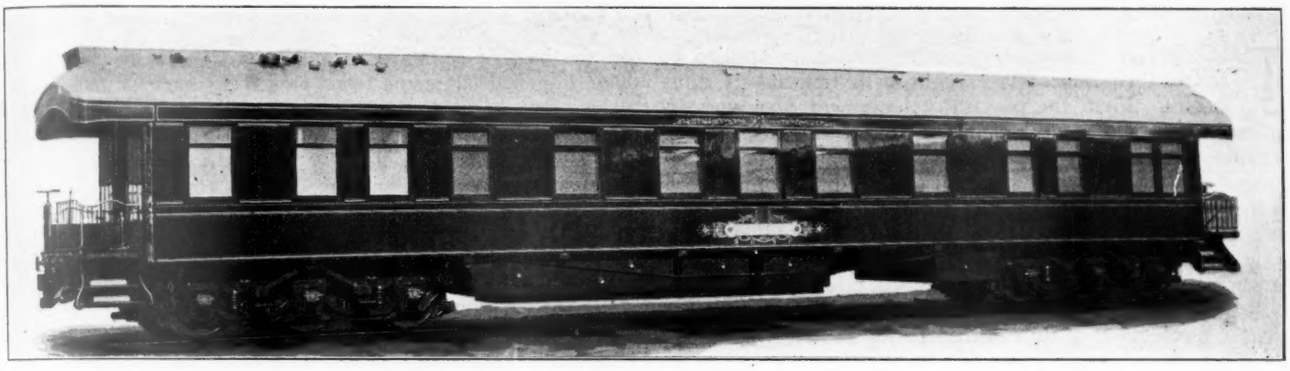
Improvements in details of car design and construction followed rapidly after the style of passenger cars with doors and platforms at the ends of the car had been accepted as standard design. As a side light on the attitude of the minds of the people of this country in those early days, it is quite natural to find that the ideals of American democracy should have found an expression in the building of cars in which all passengers were on equal footing, paid equal fares; where there were no distinctions as to classes of passengers, and all occupied a common traveling space. In Europe, however, car building took a different trend, and cars were developed with the class compartments that are in use today.

An example that embodied the most up-to-date ideas of the period when it was considered necessary to decorate and finish passenger cars elaborately in order to add to their attractiveness, is the Centennial parlor car built at the Harlan Plant in 1876 for exhibition at the Philadelphia Centennial. This car was 50 ft. long over frame, had a smoking room in one end with 6 chairs, a drawing room in the other end with 20 pivoted chairs, and a wash room and water closet in between. The interior finish of this car was very elaborate, following the style of that period, with mahogany, cherry, butternut and maple woods used in the panelling and trim.

Interior of the Centennial Parlor Car

As mentioned before, the interior decorations of the cars of this period were exceedingly ornate. Panels in different kinds of highly polished wood, inlay and marquetry work in elaborate designs, and intricate carved pieces were much used. The interior of a parlor car of this period shown herewith gives a good idea of the character of the interior finish.

In exterior appearance, the Centennial parlor car is also a fine example of the tendency of the time and will no doubt recall to many of the older readers of this the time when cars thus decorated were the rule. The abundance of gold leaf, colors and decorative work with which the cars were embellished certainly gave them an attractive and inviting appearance.



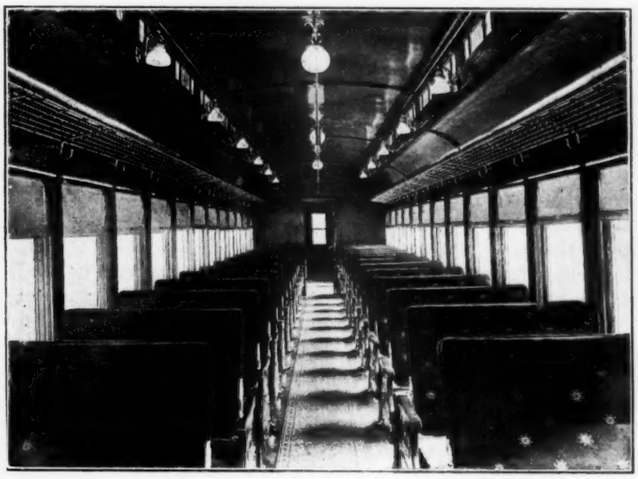
Private Car for Mrs. Lily Langtry Built in 1888

In the matter of luxuriousness and expensiveness in cars, probably the high water mark was reached in the private car built at the Harlan Plant in 1888 for Mrs. Lily Langtry. This car was the ne plus ultra in car building at the time, and it is doubtful if it has been exceeded in luxurious appointments by any car built since. The details of the finish can be imagined when it is known that the price was more than $65,000.00, and this at a time when the cost of labor and material was far less than at the present time.

Interior of Delaware & Bound Brook Car Built in 1876

The elaborateness of the finish of the cars just mentioned is in striking contrast with the simplicity of the design of the cars of the present time. There has been a decided change in the ideas of car designers and decorators since the cars of the Centennial period. A comparison of the interior of the passenger car of today, as for example the Norfolk and Western car illustrated, with the interior of a car of 1876, like the Delaware and Bound Brook, is very interesting. Not only is there a remarkable gain in simplicity and beauty in present day cars, but there also is a considerable economic saving in eliminating the expensive decorative effects of former days.

Improvements in methods and machinery used at the Harlan Plant naturally kept pace with the increasing demand for better and more elaborate passenger equipment. Numerous extensions and additions have been made to the plant and the present time finds it fully equipped with modern and up-to-date machine, forge, plate, carpenter and joinery, and upholstery shops, and with extensive car building tracks. The Harlan Plant now specializes in steel passenger car production and is experiencing one of the busiest periods in its long history.



Interior of Latest All-Steel Coach for the Norfolk & Western

EXPORTS OF LOCOMOTIVES AND CARS.—In June, 1922, forty-six locomotives, valued at $783,000, were exported from the United States. Of these 25 went to Argentina.

Four hundred and ninety-seven freight cars, valued at almost $1,000,000, were exported. Of these 200 went to Argentina and 100 to Chile.

Mechanical Refrigeration of Railroad Cars*

Early Attempts Show Difficulty of Developing Suitable Equipment; Dense-Air System Proposed

By W. M. BAXTER

THE subject of mechanical refrigeration as applied to railroad equipment is fraught with tremendous difficulties. First, the physical achievement of a successful mechanical process which will meet the multifarious demands of modern railroad transportation has not yet become a fact. Second, the economics of the problem are such as to lead the author to believe that it will be some time before a practical refrigerating machine can be applied to individual refrigerator cars. Third, from a railroad operating viewpoint any mechanically refrigerated railroad equipment must be held in specified traffic. This is a serious drawback because of the lack of universality of its use, and especially in its acceptance in interchange.

Again, being mechanical, such equipment must have the attention of attendants who must be specifically and practically trained in its maintenance and operation, and even with the most practical achievements along these lines it would be a long time before such a piece of railroad equipment would be heralded by the American railroads.

European Attempts at the Mechanical Refrigeration of Railroad Cars

The year 1912 marks approximately the beginning of serious attempts at mechanical refrigeration of railroad cars. The first effort that achieved any degree of success was that attempted by the chief of motive power and rolling stock of the Moscow-Kazan Railroad of Russia. Here a semi-absorption process was employed, consisting of refrigerating or expander coils located in the roof of the car and a connection on the outside leading from a drum of anhydrous ammonia, with a suitable expansion valve interposed. The other end of the refrigerating coil was conducted to a crude absorber located underneath the car. This absorber was in reality nothing more than a water tank having an aspirator tube placed therein. To start the process in operation it was only necessary to open the expansion valve and expand the gas in the refrigerating coil; the affinity of the water for the gas in the absorber maintained the back pressure and created the low-pressure side of the machine. It was the intention of the railroad to take the aqua ammonia thus formed in the absorber to a stationary regenerating plant and there distill off and reliquefy the anhydrous ammonia and charge it into suitable receptacles or drums which would be kept on hand and reapplied to equipment passing these points, which latter would virtually perform the same function as re-icing stations. This process failed because it was considerably cheaper to use natural ice for cooling purposes.

While attached to the American Army of Occupation as a major of engineers, the author was on one occasion sent to Poland where he saw in Warsaw an interesting car built in 1912 at Cologne, Germany, for the Russian Government Railways from the designs of M. Humboldt. In the central compartment of this car was a 10 h.p. oil engine which drove an ammonia compressor of 4 tons refrigerating capacity The condensing coils were placed under a sunshade roof on top of the car. No water was used for condensation, the day temperature of the atmosphere being depended upon to wipe off the heat of compression and thus liquefy the ammonia. The liquefied ammonia was passed to various expansion valves, one being located in each of the four refrigerating rooms into which the car was divided—two at each end of the engine compartment. By manually controlling these expansion valves different temperatures could be maintained in each of the various rooms if desired. According to a German railroad official in Warsaw, the cost of operating this car was about 80 per cent more than it would have been had natural ice been employed.

At Mayence on the Rhine, the headquarters of the French Army of Occupation, the author observed a rather new departure in car refrigeration, consisting of three insulated cars placed ahead of a central car provided with a refrigerating plant which was followed by two insulated cars. These cars were built and tried out in 1913. The traffic handled was butter and the service was from Kurgan on the Siberian border to Riga on the Baltic, a distance of about 1,500 miles. The temperature maintained in the cars was about 35 deg. F. Brine was pumped through piping and coils from the central plant which consisted of a complete refrigerating unit designed by the Linde Company, of Wiesbaden, Germany, one end of the car being partitioned off to serve as a sleeping room for two attendants. The machinery consisted of two double-acting ammonia compressors direct-connected to Diesel engines, ammonia condensers, a brine cooler, and two pumps for brine and for cooling-water circulation, respectively. A fan ventilator in connection with the condenser was set in operation when the train was standing, as otherwise the air passing through the louvres in the upper side walls of the war was not sufficient. A reservoir of cooling water was located beneath the car, as also were water-cooling radiators for the motors.

Absorption System of Mechanical Car Refrigeration

In 1913, when connected with the Canadian Pacific Railroad at Montreal as assistant to the general manager, the author began the study of mechanical refrigeration for railroad cars and built an absorption-system car, which was followed by two more cars constructed by him in the United States. The condenser and absorber were located underneath the car and the source of energy was a slow-burning charcoal fire.†

While this car from a construction point of view was a success in that it stood rough usage, met all the requirements of the Master Car Builders' Association, was cheap to build and economical in operation, nevertheless it was difficult to keep the pipe joints tight and leakproof. The real cause of failure, however, was due to boil-overs or foaming as soon as the car was switched or put in motion. The author devoted much time to this feature but was never able to prevent it. Of course, as soon as this occurred the car became inoperative, as liquor passed to the condenser and no anhydrous ammonia remained to expand in the refrigerating coils.

The Dense-Air System of Car Refrigeration

In 1917 the author abandoned all ammonia processes and attempted to achieve the result by means of the dense-air

*Abstract of paper presented at a joint meeting of the Metropolitan Section of the American Society of Mechanical Engineers, and the American Society of Refrigerating Engineers, New York, May 16, 1922. The author is president of the Baxter-Stewart Refrigerator Transport Company and vice-president of the Ideal Truck Equipment Company, Chicago.

†An illustrated description of the absorption-system refrigerator car designed by Mr. Baxter was published in the *Railway Mechanical Engineer* for December, 1916, page 662.

process. In this he has been quite successful. This system is now in use on large refrigerated motor trucks which are equipped with a one-ton dense-air refrigerating machine and have a capacity of 30,000 lb. of dressed beef at a load. The temperature maintained is 36 deg. on a 90 deg. day. A fleet of these trucks have been in continuous service for four years in the stockyards district of Chicago, handling traffic in a radius of 24 miles.

Fig. 1 shows diagrammatically the process as used on two of these trucks. The plant has a refrigerating capacity of 1000 lb. Its source of energy is a gasoline engine and the refriegerating medium is the air. With this combination the only operating supplies necessary are gasoline and oil. The refrigerating mechanism is located in a space occupying 2 ft. of the length of the body on the front end, leaving a receiving chamber for perishable goods 23 ft. 6 in. long, 7 ft. 4 in. wide, and 6 ft. 2 in. high. The refrigerating coils are located in the roof of the car and are fastened to the steel-plate and angle-iron carlines, which makes it possible to swing carcasses from the coils by meat hooks. The refrigerating machine is adjusted thermostatically to maintain the temperature of 36 deg. F. It can also be adjusted to reasonably lower room temperatures if desired, it being possible to carry the expanded air temperature of the refrigerating medium to 30 deg. below zero.

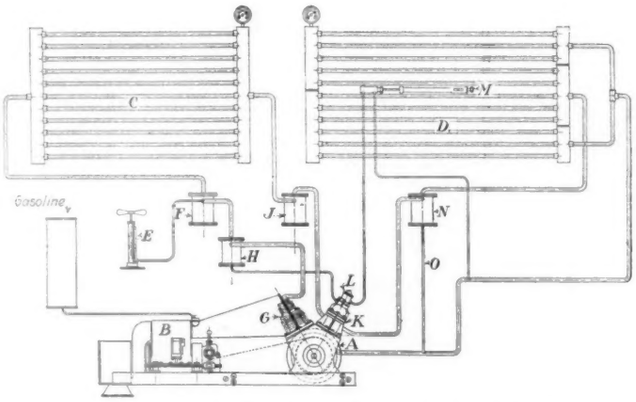


Fig. 1—Diagram of Dense Air Process of Refrigeration

The Refrigerating Machine. The dense-air process is based upon the fact that a perfect gas under pressure, expanding adiabatically and performing external work will suffer a drop in temperature proportional to the mechanical energy produced. Its fundamental advantages lie in these characteristics: There is an unlimited supply of the agent everywhere, as air is the medium; it is readily dried by the use of deliquescent salts, it is innoxious, non-poisonous, and its explosive force lies only in its expansibility under pressure; a leak may be readily sealed and the air, once dried, becomes a perfect medium of refrigeration at temperatures much lower than is possible with any agent except CO_2.

The refrigerating unit consists of a compressor employing two cylinders (5 in. bore by 5 in. stroke), and an integral expander consisting of two cylinders (4⅜ in. bore by 5 in. stroke), both sets of cylinders operating from the same crankshaft. The unique feature of this design lies in the valve mechanism and means for controlling the expander unit. The exhaust valve is a rotary valve functioning both cylinders. The inlet valves are controlled and timed by a compound rotary cam whose length is adjustable by thermostatic control, thus making it possible to alter and control by thermostat the ratio of expansion, and therefore the resultant temperature. Castor oil is used as a lubricant in both the compressor and expander sides and the oiling system is in itself a closed cycle. The expander mechanism is oiled from the oil separator in the exhaust from the compressor and fed under pressure of the high side to the cams, valve mechanism and pistons of the expander. The compressor pistons are lubricated by splash from the crankcase and an oil separator in the low side returns the oil to the crankcase.

In operation the machine requires 1¾ h.p. which is furnished by an air-cooled engine of the Henderson motorcycle type. The engine also drives an exhaust fan of approximately 4,000 cu. ft. capacity which produces a rapid flow of air across the compressed-air cooler, the compressor cylinders and gasoline engine cylinders. Proper ducts are provided to connect the various members to be cooled.

The Thermodynamic Cycle. In order to illustrate the system and to set forth the simplicity of the refrigerating process and the incidental mechanism, attention is again called to Fig. 1 in which *A* is the refrigerating unit, *B* the gasoline engine which supplies the power, *C* the compressed-air cooler and *D* the refrigerating coils.

The device is primed by the use of the hand pump *E* connected with the drier *F*, operation of the hand pump being continued until the gage indicates the density required, as the capacity of the machine depends upon the densities of the two sides, regardless of the ration of expansion. Priming, therefore, is necessary to increase the relative capacity of the device.

In operation the compressor cylinders *G* take air through their pistons from the crankcase and discharge into the cooler *C* first through the oil separator *H*, thence through the drier *F* which removes the entrained moisture, converting the hydrous content into a fixed brine and allowing the anhydrous air to pass on to the cooler *C* where the thermal coefficient of the mechanical energy performed and the specific heat due to change in volume are removed, the cooler serving to bring the temperature of the compressed air down to a point approximately 27 deg. higher than the weather temperature of the day.

The compressed air which has been cooled now passes through the secondary drier *J* to the expander, the secondary drier serving as a precautionary device to remove any moisture which may have passed the drier *F* because of high temperature at that point. In the expander *K* the air is expanded adiabatically at the ratio of expansion determined by the position of the control piston in the cylinder *L*, which is in turn controlled by the thermostat *M*. The expanded air, of extremely low temperature, is carried to the oil separator *N* in which any oil is removed before it may enter the refrigerating coils *D*, as oil in the coils produces a decided loss in efficiency. The oil extracted in the separator *N* is returned to the return pipe from the refrigerating coils *D* by a crossover *O*, both oil and air being finally returned to the crankcase from which the compressor cylinders take their supply.

The thermostatic control of the ratio of expansion is accomplished by means of a piston whose position determines the length of the cam face, which in turn determines the proportionate time of opening and closing the inlet valves, and therefore the ratio of expansion. The position of the control piston is determined thermostatically by a leak-off connected with the thermostat, by which high-pressure air is allowed to escape to the low-pressure side and move the piston proportionately to its rate of escape.

The Ethyl Chloride System

In addition to the systems described there is another, of the compression type, using ethyl chloride as the medium. Ethyl chloride boils at 54.5 deg. F. and liquefies at the low pressure of 15 lb., with condenser water at 65 deg. F. Its critical temperature is 365 deg. F., which is sufficiently high to preclude the danger of generating permanent gases. Being a neutral gas, it is possible to use thin seamless drawn copper tubes, and the joints may be soldered if desired.

As the boiling point of ethyl chloride is so low, a partial vacuum is necessary on the low side of the machine to pro-

duce the required temperature in the car. The medium is handled by a valveless rotary compressor.

The machinery is located in the end of the car and the method of operation is as follows: The medium is evaporated in the refrigerator pipes in the refrigerating compartment. The gas is then drawn to the compressor and forced into the condenser where it is liquefied. The condenser consists of a series of copper tubes placed vertically in the compartment with the compressor. The heat of compression is removed by means of a small spray of water fed to the top of the condenser, and this water is cooled by a fan so arranged that the current of air is distributed equally over the entire surface of the condenser. The power to drive this mechanism is taken from the axle of the car by means of a belt and countershaft below the compressor. Between the countershaft and the truck axle are interposed two idler pulleys upon a common guide, these pulleys being held together by springs and placed upon a guide in order that they may operate in either direction. The arrangement is such that in whichever direction the car is running the machine automatically takes up its refrigerating work. The water for cooling the condenser is carried in a tank underneath the car, from which it is pumped by a small rotary pump attached to the main shaft of the compressor. An oil engine is provided for the purpose of continuing the operation of refrigeration when the car is standing still, thus making it possible to set the car out of the train when necessary. The water for cooling the cylinder of the engine is carried in a small tank on the roof of the car.

Conclusion

As stated at the beginning of the paper and for the reasons there mentioned, it will be some time before mechanical refrigeration will be adopted on American railway cars. However, the author believes that it can be accomplished by equipping refrigerator cars with a thermosiphon system and providing a tank in the roof of the car with two compartments, one for receiving ice from regular icing stations and the other for holding a weak brine solution into which is submerged a refrigerating coil; the source of energy for cooling this brine to come from a central refrigerating-plant car carried in the train and having a capacity sufficient to refrigerate ten cars. The brine cooled in this central car would be pumped under a pressure of two or three pounds to the refrigerating coils in the various refrigerator cars, and even remove the latent heat of the brine in the tanks, if necessary, thus freezing it, thereby storing refrigerating work to be used if the car should be set out; or if the car is to be used in traffic where it is not operated from the central-plant car, then, as previously mentioned, it may be iced in the usual way, and by means of the thermosiphon system a rapid automatic circulation of the secondary refrigerating coils will take place whether the car is standing or in motion. It should be possible to store enough latent-heat energy to operate one of these cars at least 72 hours without re-icing or reconnection to the central-plant car.

This central-plant car should have installed within it a dense-air refrigerating machine of 30 tons refrigerating capacity for a ten-car unit. This machine may be driven by any standard form of gas or oil engine, preferably of the Diesel type, and the entire operation can be so designed that no water is needed to carry away the heat of compression.

Properties of Chilled-Iron Car Wheels

THE Engineering Experiment Station of the University of Illinois in co-operation with the Association of Manufacturers of Chilled Car Wheels has, for sometime past, been engaged in an investigation as to the physical properties of chilled car wheels. The scope of the investigation embraced tests to determine (1) the strains caused by mounting the wheel on its axle; (2) the strains caused by the static or wheel loads; (3) the ultimate breaking strength of flanges and strains caused by flange pressure; (4) the strains due to temperature gradients in the wheel caused by brake application; (5) incidental problems relating to the above.

The results of the investigations covering the strains caused by mounting the wheel and by static or wheel loads has been embodied in Bulletin No. 129 by J. M. Snodgrass and F. H. Guldner, the engineers in charge of the work. The strains in the wheel caused by forcing it on the axle were first determined for two 33-in. 725-lb. M.C.B. wheels. The same pair of mounted wheels was then subjected to static loads ranging from 20,000 lb. to 200,000 lb. per wheel and the resulting strains noted. The loading effect was produced by applying the load to the axle by means of a testing machine and allowing the wheels to transmit it to a pair of rails, the conditions being similar to those found in service. A similar set of tests was carried out with a pair of 33-in. 740-lb. arch plate type wheels.

A car wheel in service is subjected to stresses caused by (1) manufacturing processes, which may cause initial stresses; (2) forcing the wheel on the axle, or mounting; (3) the proportion of the car loading supported by one wheel; (4) the lateral pressure on the wheel flanges produced by rounding curves, by wind, or by the unevenness of the track; (5) non-uniform temperatures in the wheel caused by brake application; (6) centrifugal force when the speed is high.

Important initial stresses, if existent, can be traced to improper manufacture. Annealing is universally practiced and if properly performed, either removes or reduces to a small amount the inevitable initial stresses.

Forcing the wheel on the axle produces compression in a radial direction and tension in a tangential direction throughout the entire wheel. The intensity is greatest at the bore and decreases toward the tread, being negligible at the rim. On being placed in service, the wheel encounters conditions that produce an exceedingly complex stress distribution within it. Only those due to static load are considered in the present report.

Chemical analyses were made of several wheels and specimens were taken out for tensile and compressive tests. Hardness tests, both by the Brinell method and with the scleroscope were also made in an attempt to associate the quality of hardness with other physical properties.

During the investigation, a Berry strain gage was used to determine distortion. By this instrument unit strains could be read directly to 0.0001 in. and by estimation, to one tenth of this figure. A 600,000 lb. Riehle testing machine with an autographic attachment was used for determining the mounting pressure and later for the application of static or wheel loads.

The results of the investigation may be summarized as follows:

(1) The tensile strength of the metal taken from different parts of the plates of three wheels ranged from 23,300 lb. to 32,800 lb. per sq. in. and the modulus of elasticity ranged from 14,000,000 lb. to 28,000,000 lb. per sq. in. It is probable that these variations may be explained by variations in chemical composition of the several specimens and variations in the treatment of the wheels after casting. Whatever be the reason, however, they suggest that a study of the metallurgy of wheel irons offers possibilities of improvement by which the higher values obtained in these tests might be consistently maintained or possibly exceeded in the future.

(2) No distinct relation was apparent between the ultimate strength of wheel iron and either the Brinell or the scleroscope hardness, nor could a constant relation be determined between the Brinell and scleroscope results. Brinell hardness in the body of the wheel varied from 110 to 150 and scleroscope hardness from 30 to 40.

(3) In forcing the 625-lb. and 725-lb. M.C.B. or Washburn type of wheel on an axle the maximum tensile strain or stress is a tangential or "hoop" strain or stress occurring at the bore, and it may be on either the inner or the outer face of the wheel.

On the outer face of this type of wheel in a radial direction the strains or stresses are compressive. They are a maximum at the bore and, in traversing the section of the wheel from the bore toward the tread, they decrease up to a point where the radius equals the mean radius of the core, beyond which an increase occurs up to a point at or near the intersection of the inner and outer plates, after which a decrease again occurs.

On the inner face in a radial direction the strains or stresses are likewise compressive and a maximum at the bore. If a similar traverse be made across the section, these strains or stresses decrease up to a point where the radius equals the mean radius of the core; they are then of approximately uniform intensity up to a point whose radius is equal to the outer radius of the core; beyond this point they again decrease.

Tensile and compression stresses as high as 17,000 lb. were observed.

(4) In pressing the 740-lb. arch plate wheels on the axle the maximum tensile strain or stress was a tangential strain or stress on the inner face and at the bore. In general, the tensile stresses on either face of the wheel were a maximum next to the bore and steadily decreased toward the tread.

With respect to the strains or stresses in a radial direction on the outer face, no measurements were taken in close proximity to the bore, and accordingly nothing definite can be stated concerning their intensity in this region. However, the strain in a radial direction taken nearest to the bore was relatively small and was tension in one wheel and compression in the other. This fact may be due to bending action in conjunction with the thrust of mounting. As the tread was approached, the strains and hence the stresses became compressive and of increasing intensity, reaching a maximum at a point whose radius was equal to the mean radius of the core, beyond which they again decreased.

On the inner face over the region investigated, the strains or stresses in the radial direction were compressive, reaching the maximum nearest the bore and decreasing to a minimum at a point whose radius was equal to the mean radius of the core, after which they again increased.

Stresses observed were as high as 16,800 lb. for tension and 13,700 lb. for compression.

(5) In the regions of the chaplets and core holes, pressing the wheel on the axle causes tensile strains in a tangential direction which are of lesser intensity than, but approach in magnitude to, those at the bore.

(6) The stresses and strains in the brackets which are produced in a radial direction by mounting are relatively insignificant.

(7) The strains caused by mounting the wheels on the axles, when mounting alone is considered, are greatest in the hub near the axles. These strains, although apparently high in the case of the greatest values recorded, are steady and not repeated as is the case with the majority of strains produced in service. Moreover, these highest strains extend through a comparatively thin layer of metal near the axle and this strained layer is backed by other layers of less strained metal.

(8) In general the static load is transmitted from hub to rail, mainly through the outer plate, while the smaller portion of the load goes through the inner plate. This effect is more pronounced in the 740-lb. arch plate than in the 725-lb. M.C.B. type of wheel. This division of the load seems desirable in that the inner plate may be considered as affording a reserve capacity for the purpose of absorbing the effect of the side thrust exerted on the flange when rounding curves.

(9) Pressing the wheel on the axle is much more effective in producing stress or strain within the wheel than the normal static load, and it therefore follows that the addition of the normal static load does not greatly add to or otherwise modify the more important of the existent strains caused by mounting.

(10) Abnormally heavy loads, in the absence of impact, side thrust, etc., may be sustained by wheels without increasing the normal strains, already existent, to such an extent as to seriously stress the wheel.

(11) The maximum strains reported, caused by the combined effects of mounting and static load, appear large when expressed in terms of the stress that would exist if the material were subjected to simple tension or simple compression. As previously stated, these strains are produced in the main by the mounting load and the more important strains are those of tension, which in general are greatest near the bore of the wheel. The character of the strains and the backing of the material most strained by less strained material, probably makes possible without injury to the material greater strains or deformations than would be allowable in the case of material not so supported and subjected to simple tensile stress. As previously stated, the problem is one of compound stress, and the method used in computing the stresses reported is thought to give the highest values for these that could be expected under such conditions. Any error in estimating, from the stress values determined in this way, when elastic failure might take place, would be upon the side of safety. In this connection it should also be remembered that the stresses reported are those produced by two forms of wheel loading only, and that the strains and stresses resulting from these two forms of loading (mounting and static) may be materially modified by additional stress-producing factors to which a wheel may be subjected in service.

The First French Railway Instruction Car

By Raymond Legonne

THE Paris Orleans Railway of France has always been a leader in the instruction of apprentices and the training of young men for supervisory positions. The road has had special training courses for some time and is now supplementing the work with a well equipped instruction car, recently built. This car is used to give practical and theoretical training to men selected by examination from the enginemen, gang foremen, and assistant foremen of the company. The men are examined four times a year in the car where apparatus, charts and schedules used in their work are provided and full information is given by the superintendent appointed as instructor.

The instruction car and auxiliary car, which are operated together, are 36 ft. 6 in. and 35 ft. long respectively and are of the most modern construction. The apparatus in the car includes complete Westinghouse air brake equipment with an air pump which has been cross sectioned and fitted with small electric lamps which, as they are illuminated or darkened show the working of the different valves. Other equipment in the car includes steam heating apparatus, electric and air communication apparatus, injectors, lubricators and other locomotive accessories.

On a platform suspended with counterweights from the ceiling of the car is a complete small sized model of track, sidings and signal apparatus electrically operated with semaphores, bells, crossing signals and other apparatus in use on the system. The car can be darkened when required for the use of moving pictures in connection with the instruction work.

Three Unique Car Shop Devices

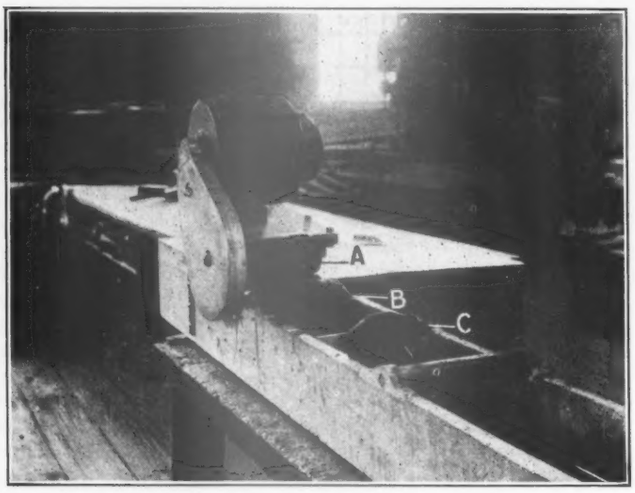
AT one of the car shops of a railroad in the east many appliances have been developed for facilitating car repair work. Among the most interesting are those described below.

Machine for Painting Car Siding

When siding on box cars is renewed it is usually necessary to apply two coats of paint. The first coat must dry for a day before the second is applied, which causes delay in getting cars off the repair track. In the case of foreign equipment, the per diem for the extra day often makes a net loss if only minor repairs are made. In order to avoid holding cars for painting, this shop applies one coat of paint to the siding before it is put on the car. The painting machine is useful for speeding up this work.

General View of Machine for Painting Siding

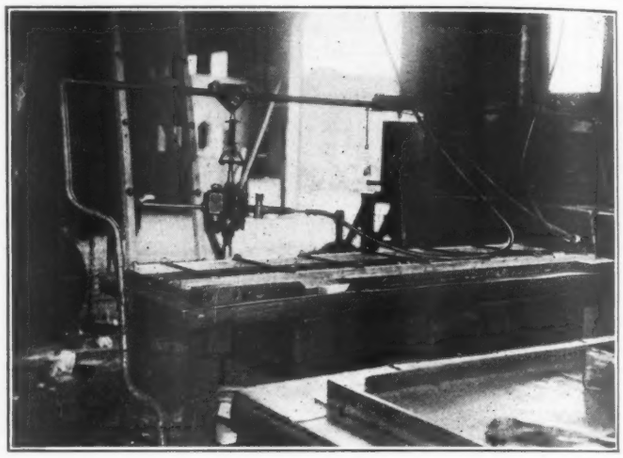
The device takes up comparatively little space, being about 10 ft. long and 10 in. wide. The operating parts are shown in the first illustration. The motor is geared down and drives the 3½ in. by 7 in. wooden roller *A*. The frame carrying the motor and upper roller is pivoted so that the roller can be raised when a piece of siding is fed under it.



Details of Painting Machine

Roller *A* rests on another 3½ in. roller which is in contact with a 6 in. roller *B* and drives it by friction. The large roller is covered with lamb's wool and the under side dips into paint in a tank in the base.

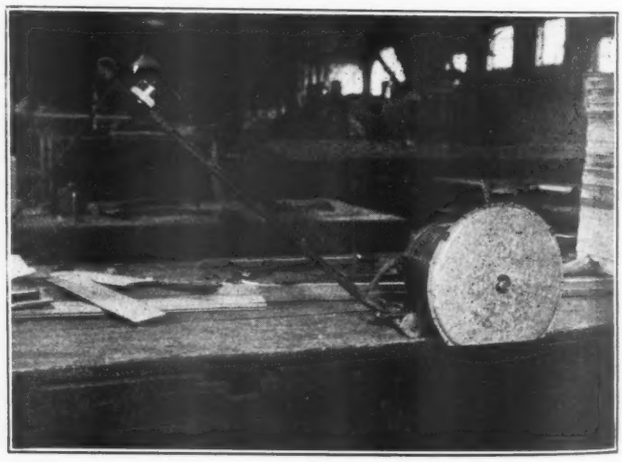
The siding is fed in between the wooden rollers and passes over the lamb's wool roller which moves in the opposite direction. The pressure between the roller and the siding forces the paint out of the lamb's wool and the under side of the board is practically flooded with paint. About a foot beyond this roller is a brush *C* which removes any excess of paint and smooths the surface. The board then passes over two small wooden rollers and as it comes out is placed on a rack to dry. The siding passes through at about 50 ft. per min. but even at this speed no paint slops off the rollers, every drop being returned to the tank.



Device for Assembling Car Ladders

Assembling Car Ladders

Large numbers of cars on this road are equipped with ladders having wooden stiles and straight iron rungs. Assembling these ladders is a tedious operation if done without special equipment but the work is readily handled with the frame shown in the photograph. This consists of a bench with an iron top on which all the required equipment is mounted. In assembling the ladders the ⅝ in. carriage bolts are first inserted through the stiles which are then placed on the frame, being held in the proper position by angle irons. The rungs are put in place and the nuts started on. The operators then place the air motor socket over each nut in turn and tighten them. The supporting frame of pipe is pivoted and can be swung over either stile. When all the nuts have been tightened the air hammer is used to rivet over the ends of the bolts.



Motor-Driven Saw for Trimming Edges of Roofs

Saw for Cutting Roofs

A good use for a discarded motor is shown in the illustration herewith. This motor, of ½ hp. and operating at

1,750 r.p.m., is mounted on four small wheels and drives a 14 in. saw. The bottom of the guard is slightly above the level of the wheels and the saw projects down 1¼ in. below the guard. A substantial handle is provided and the wires from the motor run through a switch on the handle. This makes a convenient device for sawing the edges of freight car roofs.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Proof of Derailment Under Rule 32

Wabash car No. 66272 was extensively damaged while being handled in a Chesapeake & Ohio train at Huntington, W. Va., August 24, 1920, and disposition was requested under Rule 120. The Chesapeake & Ohio was authorized to repair the car, charging for the work under Rule 120, and the car was returned to service April 13, 1921. Shortly after that, however, a representative of the Wabash, while at the Huntington shops, secured a copy of a report by the foreman who picked up the damaged car, in which he stated that the car was derailed, the cause being the bursting of an air hose on another car in the train. In the meantime the writer of the report had been killed, but the Chesapeake & Ohio presented affidavits from other employees showing that there was no derailment.

The Arbitration Committee accepted the original report of the accident, showing derailment, thus making the handling line responsible for the cost of repairs.—*Case No.* 1221, *Chesapeake & Ohio vs. Wabash.*

Damage Caused by Break in Two Due to Broken Carrier Iron Bolts

Pere Marquette car No. 52591 was extensively damaged in a Big Four train on February 21, 1921, when the train broke in two due to the failure of the carrier iron bolts on another car. There was no derailment. The damaged car was several cars removed from the break in two and the cars adjoining it were neither of them damaged. The car owner claimed that the coupler on the car which caused the break in two was out of position and defective, bringing the case under paragraph (e), Rule 32. The Big Four claimed that the damage was caused under conditions covered by interpretation No. 5, Rule 32.

The Arbitration Committee upheld the contention of the handling line, ruling that the damage to the car is at owner's responsibility.—*Case No.* 1225, *Cleveland, Cincinnati, Chicago & St. Louis vs. Pere Marquette.*

Handling Line Protection for Wrong Repairs Under Rule 70

On January 6, 1921, Chesapeake & Ohio car No. 37394 was delivered by the St. Louis-San Francisco to the Atchison, Topeka & Santa Fe at Kansas City, Mo. At the time the car was received no exceptions were taken to the wheels but on the following day at another point on the latter line the inspection disclosed one pair of cast iron wheels in place of Davis cast steel wheels. The car was moved to Chicago where the wrong wheels were removed and replaced with cast steel wheels. The Atchison, Topeka & Santa Fe made request from the St. Louis-San Francisco for protection to cover the wrong wheels, inspection having disclosed that the cast iron wheels were applied prior to the delivery of the car to its line. The St. Louis-San Francisco refused to issue a defect card, stating that the car had been through several interchanges, including that to the St. Louis-San Francisco, with no exceptions noted and that the wheels were not changed while in its possession.

The Arbitration Committee decided that, assuming the car was stenciled for cast steel wheels at the time of its receipt from the St. Louis-San Francisco, the Santa Fe is responsible under Rule 70.—*Case No.* 1226, *Atchison, Topeka & Santa Fe vs. St. Louis-San Francisco.*

Accident Damages Must Be Reported With Owner's Defects Under Rule 120

Atlantic Coast Line box car No. 27455 was made bad order on arrival at the Texarkana yard of the Texas & Pacific under load, October 31, 1920, on account of a broken transom and loose and decayed siding. Later, while a switch engine was moving the car in the yard, a rail broke, causing it to turn over against a bank, when the entire roof slid off and the brake beam connections were bent. In picking up the car the brake cylinder was broken and the truss rods bent. When the car arrived at the shop inspection disclosed that none of the sills or siding were broken but that all the siding was rotted away from the sills and that the sills and cross ties were badly decayed. These conditions were reported to the owner under Rule 120 without advising the owner that the car had been in an accident. Subsequently a repair card marked "No Bill" was forwarded to the Atlantic Coast Line, covering the wreck damage, on receipt of which the Atlantic Coast Line declined responsibility for any portion of the repairs because of the fact that the car had been damaged in an accident. The Texas & Pacific cited Rule 41 and Arbitration Cases Nos. 697, 1012 and 1120, to support its view that the car owner should accept charges for the renewal of all parts not broken in the accident. The Atlantic Coast Line cited Arbitration Cases Nos. 709,846 and 1,070 to support its view that sufficient damage had been done to the car to contribute to or be the cause of damage to other parts of the car, renewal of which would otherwise be at owner's responsibility.

The Arbitration Committee, stating that if all defects had been reported in the inspection statement required by Rule 120, a mutual understanding could have been reached before repairs were made, decided that the bill against the car owner should be withdrawn.—*Case No.* 1223, *Texas & Pacific vs. Atlantic Coast Line.*

Time Limit for Rendering Car Repair Bills

A car owned by the Pacific Coast Railroad was repaired by the Lehigh Valley on July 28, 1920. The bill for repairs was rendered in the July, 1921, account, but was not mailed from Philadelphia until August 11, and was received by the Pacific Coast Railroad on August 15, 1921. The owner contended that the bill was outlawed since it was not mailed until one year and fourteen days after the car had been repaired. The Lehigh Valley maintained that rendering the bill in its July account brought it within the year's time allowed by Rule 91.

The Arbitration Committee sustained the contention of the Lehigh Valley, deciding that the bill should be paid.—*Case No.* 1228, *Lehigh Valley vs. Pacific Coast Railroad.*

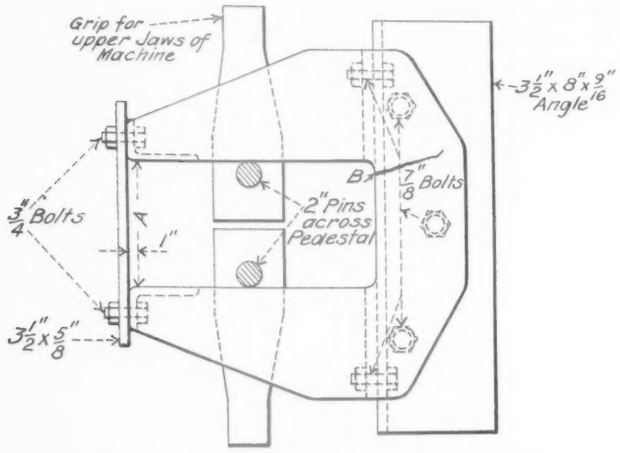
The Best Metal for Pedestal Wearing Faces

Pullman Tests Lead to Adoption of High Manganese Electric Cast Steel in Built-Up Pedestals

THE trucks under all new Pullman equipment built since the close of Railroad Administration control in 1920, have been fitted with pedestals built up of open hearth steel plates and wearing surfaces of special steel angles riveted to the front and back plates.* These pedestals were adopted because of the occasional failure of the reinforced cast iron pedestals formerly applied under abnormal conditions such as those brought about by a derailment. The built-up pedestals have twice the strength of the former reinforced type to resist failure at the corner, as has been demonstrated by tests in a tensile machine, conducted as shown in the sketch. The reinforced cast iron pedestals broke under a load of 26,000 lb. while the steel pedestals, after shearing a tie strap bolt, failed under a load of 52,000 lb.

At the outset, however, it was recognized that the conditions of wear between the pedestal guiding faces and the journal boxes would not be as good as obtained with gray iron pedestals and gray iron boxes, and a series of wear tests were undertaken to develop the best possible metal which would be mechanically practicable for use in the pedestal guide angles, from the standpoint of cutting, or being cut by any of the metals that might be used in passenger car journal boxes.

The wear tests were performed on a shaper. Tests pieces of journal box material approximately 4 in. long by 1 in. wide were set into an iron block weighing 400 lb. The pieces

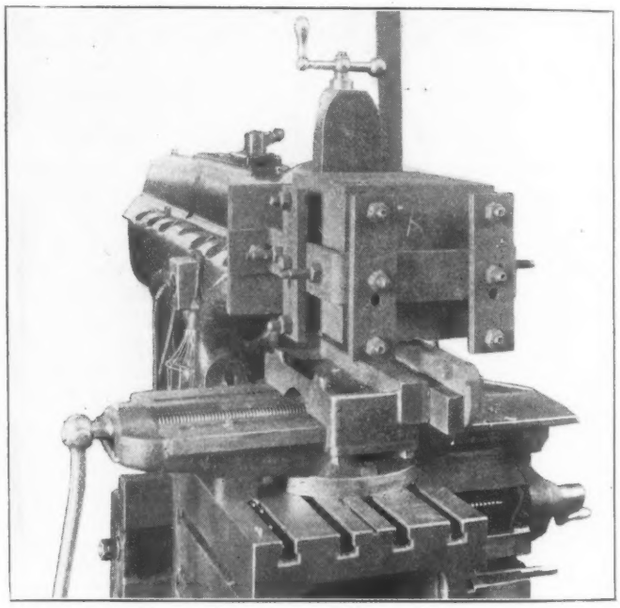


Method of Comparing Strength of Truck Pedestals

of pedestal guide metal were clamped to the shaper table and the journal box metal, designated as the shoe in the accompanying summary of the tests, weighed by the iron block, was moved back and forth on the wear plate by the shaper ram. Thus, 4 sq. in. of shoe surface, under a load of approximately 100 lb. per sq. in., was subjected to a 4-in. travel from 30 to 35 times a minute.

The pedestal wear plate materials tested included cast iron, a semi-steel-gray iron mixture, heat treated malleable iron, open hearth steel samples of varying carbon contents, chrome-vanadium steel, spring steel and high manganese electric cast steel. The medium soft cast iron wear plates were tested with shoes (representing the journal box) of cast iron, low carbon open hearth steel and malleable iron. The cast iron on cast iron wore appreciably, but did not cut. The cast iron on malleable iron, heat treated, showed very little wear and no cutting, but the material is not practicable for journal box construction. With open hearth steel and the treated malleable iron shoes, the cast iron developed considerable cutting of wearing surfaces.

The semi-steel samples, ranging in Scleroscope hardness from 38 to 70, depending on the carbon, some heat treated and others case-hardened, were all tested with malleable iron shoes. Most of these samples were subjected to heavy cutting on both surfaces or to excessive wear. The only exception



Pedestal Wearing Plate and the Shoe of Journal Box Metal Mounted on a Shaper

to this was a sample with a deep chill which subjected the malleable iron to but slight wear. The chilled wear plate, however, was considered too brittle to be available for practical use.

As originally designed the built-up pedestals were fitted with rolled steel wear plates of axle steel. A number of samples of this class of material, some with the surface finished and others with the surface unfinished, representing a considerable range of heat treatment and case-hardening, were tested with shoes of the various materials which might possibly be used in journal boxes. The shoes and wear plates were badly cut in all of these tests.

Good results were obtained with a comparatively low carbon open hearth steel, case-hardened, with a heat treated chrome-vanadium steel, a tempered spring steel and heat treated electric cast steel. With the exception of the latter, however, none of these metals are practicable for use as pedestal wear plates, either because of the cost of manufacture or brittleness of the metal. The high manganese electric cast steel, heat treated to produce a Brinell hardness of between 450 and 500, produced excellent results with both malleable iron and steel shoes, the wear being very slight and the surfaces showing no evidence of cutting. Furthermore,

*For description of this pedestal see an article in the *Railway Mechanical Engineer* for September, 1920, page 589.

this metal possesses the required mechanical properties and has been adopted for the wear plates in place of the rolled section of axle steel originally used.

A summary of the results is presented in the accompanying table, in which all set pieces not specified to the contrary, have both wearing surfaces machined smooth.

SUMMARY OF TEST RESULTS

Test No.	Pedestal wear plate: Material	Sclero-scope hardness	Shoe	No. of ft. Travel	Observed Wear On: Wear Plate	Observed Wear On: Shoe	Approximate equivalent shoe wear per 1,000 ft. travel	Remarks
1	C. I. Medium soft..	40	Cast iron	7,000	.016	.318	.045428	Started wear immediately; surfaces smooth
2	C. I. Medium soft..	..	O.H.S., 19 C	1,633.33	.078	.0205	.012551	Cutting at start of test
3	C. I. Medium soft..	..	Mall. iron	6,000	Could not be accurately measured due to cut surface	.005	.000833	Surfaces cut considerably
4	C. I. Medium soft..	..	Mall. iron, heat treated.	6,000	No measurable wear	.002	.000333	No cutting of either surface; too brittle for practical use
5	Semi-steel—gray iron mixture.	38	Mall. iron	466.66	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both badly cut
6	Semi-steel—gray iron mixture, special treatment.	44	Mall. iron	600	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both badly cut
7	Semi-steel—gray iron mixture, special treatment.	42	Mall. iron	700	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both badly cut, wear plate had slight chill that was penetrated in grinding surface preparatory for test
8	Semi-steel—gray iron mixture, medium chill.	70	Mall. iron	1,166.66	None	.0945	.08046	Heavy wear on mall. iron, wear plate had slight cavities that picked up shoe metal
9	Semi-steel—gray iron mixture, high sulphur added.	42	Mall. iron	7,000	.023	.0365	.005214	Both cut
10	Semi-steel—gray iron mixture, deep chill.	69	Mall. iron	7,000	None	.0205	.002929	Good combination, but wear plate is brittle and will not stand riveting
11	Mall. iron, heat treated.	..	Mall. iron, heat treated.	1,600	.....	.12	.0750	Cutting after fifty minutes
12	O. H. S. .10 C, as rolled, not machined.	20	Mall. iron	315	Could not be accurately measured due to rough surface and cutting	Could not be accurately measured due to cut surface	.....	Both badly cut
13	O. H. S. .46 C.....	..	Mall. iron, heat treated.	1,600	.003	.076	.04750	Both badly cut
14	O. H. S. .46 C, as rolled, not machined.	..	Mall. iron	1,800	.003	.077	.042777	Both badly cut
15	O. H. S. 46 C.....	..	Cast iron	3,996	.009	.108	.027027	Both badly cut
16	Axle steel	..	O.H.S., 19 C	5,133.33	.046	.05	.009740	Cutting at start of test
17	H. T. axle steel, .49 C	..	Mall. iron, heat treated.	1,200	Could not be accurately measured due to cut surface	.12	.10	Cutting after twenty minutes, both badly cut
18	H. T. axle steel, .49 C, not machined.	..	Mall. iron, heat treated.	1,400	Only slightly worn, not measured	.116	.082857	Shoe badly cut
19	H. T. axle steel, .49 C, not finished.	..	Cast iron	1,600	Could not be accurately measured due to cut surface	.12	.0750	Cutting in twenty-five minutes; wear plate slightly worn
20	Axle steel, .49 C, case-hardened, not finished.	..	Cast iron	2,700	Could not be accurately measured due to cut surface	.073	.027037	Shoe badly cut, wear plate slightly
21	Axle steel, .40 C, heat treated, drawn at 1000° F.....	40	Mall. iron	583.33	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both cut and worn badly
22	Axle steel, .40 C, heat treated, drawn at 500° F.....	40	Mall. iron	1,050	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both cut and worn badly
23	Axle steel, .40 C, quenched, not drawn	40	Mall. iron	1,050	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both cut and worn badly
24	Axle steel, .49 C, cyanide hardened, not machined.....	..	O.H.S., 19 C	800	Could not be accurately measured due to rough surface and cutting	.047	.058750	Both cut immediately
25	Axle steel, .49 C, cyanide hardened...	..	O.H.S., 19 C	1,600	Could not be accurately measured due to cut surface	.102	.063750	Cutting after twenty minutes
26	O.H.S., .25 C, case-hardened with 1.10 carbon case, not finished	86	Mall. iron	4,200	None	.043	.010238	Rough surface cuts shoe
27	O.H.S., .25 C, case-hardened with 1.10 carbon case.....	..	Mall. iron	4,200	None	.034	.008095	Good combination, but cost of manufacture too expensive
28	Tire steel, .67 C, heat treated, drawn at 800° F.....	50	Mall. iron	933.33	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	.....	Both badly cut
29	Chrome vanadium steel, normalized...	40–45	O.H.S., 19 C	5,950	.017	.0745	.012521	Both cut
30	Chrome vanadium steel, heat treated, quenched at 1550° F	88–92	O.H.S., 19 C	7,000	.001	.0005	.000071	Good combination, but too brittle for practical use
31	Spring steel, annealed	39–43	O.H.S., 19 C	4,550	.015	.0715	.015714	Both cut
32	Spring steel, tempered	60–65	O.H.S., 19 C	7,000	.001	.0105	.00150	Good combination, but impractical for use on standard pedestal
33	Electric cast steel, heat treated.....	475*	O.H.S., 19 C	7,700	.002	.0085	.001104	Good combination; friction surfaces glazed
34	Electric cast steel, heat treated.....	475*	1.00 C annealed spring steel.	7,000	.0035	.0005	.000071	Good combination; friction surfaces glazed
35	Electric cast steel, heat treated.....	475*	Mall. iron	7,000	.0005	.0095	.001357	Good combination; friction surfaces glazed
36	Electric cast steel heat treated.....	475*	Mall. iron	6,000	None	No measurable wear	.....	Excellent; friction surfaces glazed

*Brinell

Eliminate Costly Hand Fitting and Filing

Many Operations, More Profitably Done on Modern Milling or Grinding Machines than by Filing, Are Outlined

By M. H. Williams

THE continued extensive use of files in some railroad shops is largely due to precedent, and the sooner machines are installed to eliminate hand fitting and filing the better. A file is cheap. Unfortunately the man behind a file is expensive when compared with the same man operating a modern milling or grinding machine which does the same work far better and in less time. It is considered a good investment to replace an old style lathe by a modern one, where a saving of 10 to 20 per cent can be effected. It is a better investment to install enough modern machines so that filing or other hand fitting operations will be unnecessary.

It would take too much space to consider in detail all railroad shop operations which can be done more profitably by machines than by hand filing but several of the more important of these operations are mentioned below.

Taper Frame Bolts. Taper cylinder and frame bolts are used to hold two members together and, in addition, to prevent the two members from shifting on each other. They, therefore, are in reality enlarged taper pins which, in order to function properly, must be a perfect fit in the taper reamed holes. The closeness of the fit should be similar to the fit of a twist drill in a drill socket, or a lathe center in a lathe. Taper bolts are generally turned, being finally finished with a file. In some shops they are made on bolt skimming machines. Owing to the accuracy essential they should all be ground the same as drill manufacturers grind twist drill shanks. Bolt grinding has been practiced to a limited extent and it no doubt will be extended as grinding becomes more general.

A type of machine suitable for grinding bolts is the 10 by 36-in. plain cylindrical grinder, shown grinding a wrist pin in Fig. 1. After the installation of grinding machines, taper bolts are rough turned in quantities to step sizes, varying by about 1/16 in. diameter, and placed in stock. When required for use they are ground to the required taper and diameter. This is a quicker method than finish turning and then filing. In addition, the surfaces are smoother, more uniform and not full of the humps which are unavoidable with file finishing. As a result, the bolts are practically perfect fits in the taper holes. Some doubt may be expressed as to the advisability or economy of bolt grinding. The best way of testing the method is to arrange with some grinding machine manufacturer to grind a number of rough-turned bolts, the short time required being recorded and the finish of the surfaces noted. This will generally convince the most skeptical that grinding is the proper method to follow.

Piston and Valve Rods. When repairing piston and valve rods, these rods are commonly ground on gap piston

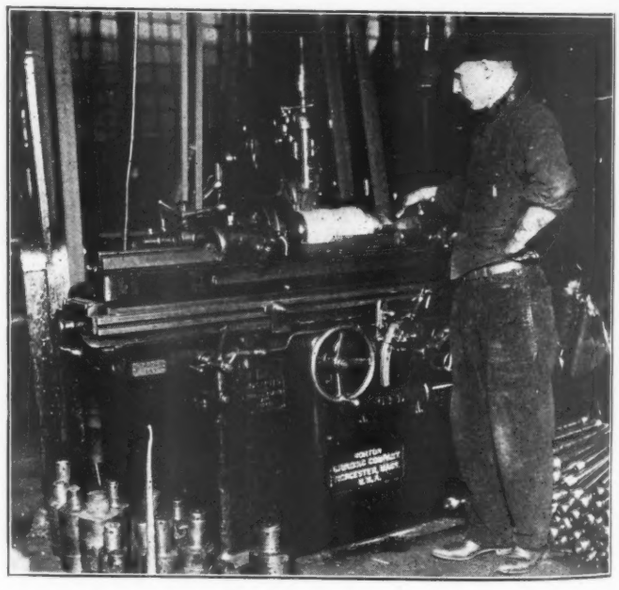


Fig. 1—10-In. by 36-In. Plain Cylindrical Grinder Finishing Wrist Pin

rod grinding machines and many roads have convincing data comparing the grade, finish and cost of turning and filing vs. grinding. What shop is there which, once having used a piston rod grinding machine, would willingly go back to turning and filing?

Piston and valve rod grinding should be carried one step further and made to include all new rods. For this purpose a grinder having about 20-in. swing by 80 to 120 in. long should be selected, the length of the machine depending on

the length of piston rods common to the road. In order to grind the taper ends this machine must be provided with a swiveling table similar to the ordinary plain grinding machines. (This is a feature not common to gap grinders.) Where these machines have been introduced it is the custom to rough turn the rods about 1/32 in. large and grind both the straight and taper surfaces to the required sizes. Superior fits in the crosshead and piston head are thus secured as well as round, smooth and straight rods which tend to eliminate packing troubles. Grinding machines of this size are also used for grinding axles, crank-pins, crosshead and other pins, therefore being kept fully employed.

Crank-Pins. These pins are generally turned on center lathes, although the large turret lathe is now finding favor for this purpose. The most approved method is to rough

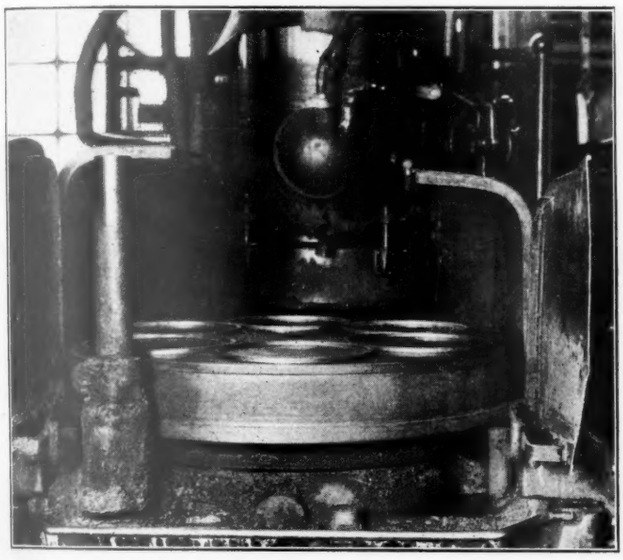


Fig. 2—Rotary Surface Grinder Equipped with Magnetic Chuck Grinding Packing Rings

machine the surfaces fitting the rod brass about 1/32 in. large and afterwards transfer to grinding machines for final finishing. This results in a superior bearing surface and requires less time than rough turning, finish turning, filing and smoothing with emery paper, or turning and rolling.

Locomotive Axles. To a limited extent locomotive axles have been rough turned on center lathes and afterwards finished on grinding machines. While this was never a filing job it is mentioned to call attention to the uses that can be made of a large grinding machine.

Packing Rings. There is not much filing on packing rings. However, in the line with modern machine shop methods, packing rings in some shops are blanked out to step thicknesses and placed in stock. When necessary to fit them to piston grooves, the sides are ground on rotary surface grinders of the type shown in Fig. 2. This results in the rings fitting the grooves better than when simply turned on their sides. Owing to the small amount of time required when setting rings on a magnetic chuck, grinding is quicker than turning for finishing the sides. This is especially true where each ring is individually fitted to varying widths of piston grooves. The rotary surface grinder can also be used for other purposes as explained later on.

Crosshead Pins. In a number of shops crosshead pins are blanked out in quantities on turret lathes and placed in stock. When finishing to fit the crosshead, the taper ends and bearing surfaces are ground on 10 by 36 in. grinding machines. This results in economical blanking out and finishing, and well fitting parts. Files should not be used on these parts.

Piston Valves. There is not much filing on piston valves. In making new or repairing old valves considerable time is saved by providing proper gages so that the parts shall be interchangeable. Each part should be made to limit gages or micrometer measurements so that, when assembling, the parts will go together without hand fitting or filing. This can readily be accomplished by devoting a little time to the question of tolerances for the various parts going to make up the valve. The sides of piston valve packing rings are economically ground on rotary surface grinders. In some shops the outside surfaces are ground after the rings have been cut at the lap joint, the rings being held in a compressed state on an arbor. This makes it possible to finish the rings to the same diameter as the bushing and insure a steam-tight joint all the way around the ring when in the bushing. This is doing just what the makers of good automobiles do, the large cylindrical grinder mentioned being suitable for this purpose.

Main Rods. It may appear that files must be used on main rods, but what does experience show? For worn rods the following repairs may be necessary: Jaws worn or out of square, sides rough, brasses requiring renewals, wedges worn, or new ones necessary, etc. Starting with the rod jaw, these when worn are readily milled on heavy vertical milling machines, or the larger vertical plain knee type machine, as shown in Fig. 3. About the only extra appliances required are small helical milling cutters, lower supports for the cutters, suitable clamping devices for holding rods on the table and a truss or overhead crane to support the overhanging end of the rod. With these devices at hand it is easy to clamp a rod to the machine table and true up the jaws. Owing to the small amount of metal to be

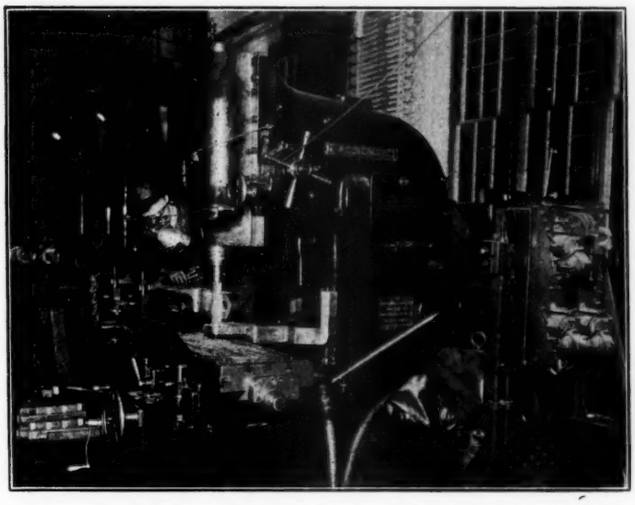


Fig. 3—Powerful Knee-Type Milling Machine Truing Main Rod Jaw

removed (only enough to true up the jaw and remove the high spots), the milling feeds average from 2 to 4 in. per min. As the jaws generally do not have a total length of surface requiring truing exceeding 20 in., the time for milling is a small item. Surfaces finished in this manner are smoother, more regular and more nearly square than when done by an expert filer. One great advantage of milling rod jaws is the greater accuracy of the surface, making it possible to machine the rod brasses to the correct size to fit the jaws, thus eliminating filing.

The sides of main rod front ends when worn are readily finished on large 22 in. by 7 ft. surface grinders of the type shown in Fig. 4, the customary plan being to hold the rod on a magnetic chuck. In the event of new wedges, blocks or front brasses being added to a rod, these parts are put in place in the rod at the same time and ground with the rod.

As a result all the members are flush with the sides of the rod. With all this work done by machinery there is not much left for the file. The same grinding machine is also used for finishing guide bars, this work helping to keep it busy.

Rod Brasses. When rod jaws are milled or even filed true, the brasses are readily machined on an ordinary planer, crank planer, shaper or milling machine to fit the rods, without filing. To do this properly it is necessary to carefully measure the rod and brasses which is best done with micrometer calipers. This may take additional time both in measuring and machining. However, it is much easier and quicker to make these to correct size during the machining operation than to half do the machine work and finish with a lot of laborious filing. When the parts are machined accurately to size, an improvement in the quality of fitting follows. A file is used only to remove the burrs.

Rod Keys. By modern methods rod keys are either milled complete from the rough forging on plain knee type milling machines, or partly milled and finish ground on surface grinders. This is much quicker than planing and afterwards finishing with a file.

Side Rods. The file is not used to any extent on side rods. However, should the ends require refinishing they are readily ground on the rectangular surface grinders, or where battered, they can be ground on swing grinders.

Knuckle Pins. Like crosshead pins, knuckle pins are economically manufactured in quantities for stock on large turret lathes or automatic machines. When fitting to varying sized rods, the taper ends and straight surfaces are ground on a 10 by 36 in. grinding machine. Case-hardened pins are finished as readily as soft pins, grinding having

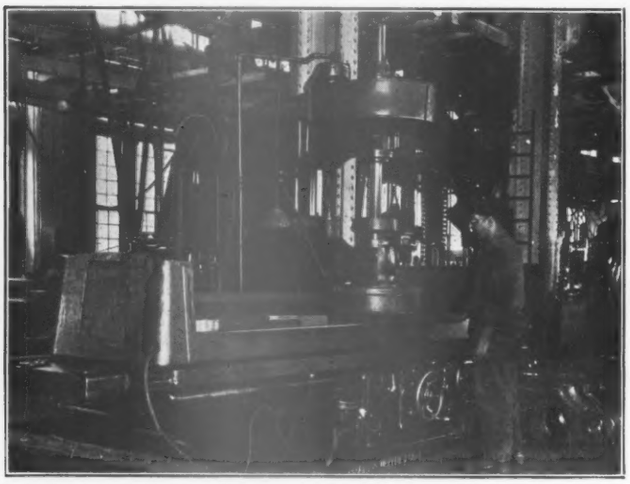


Fig. 4—Surface Grinder Equipped with Magnetic Chuck; Can Be Used for Finishing Links, Main Rods and Many Other Parts

the advantage of the desired smooth bearing surfaces. There is no filing here.

Knuckle Pin Bushings. Bushings for knuckle pins should have true and smooth bearing surfaces, best obtained by grinding the bore. This method applies to soft or case-hardened material and is quicker than lapping. While somewhat foreign to the subject, mention will be made of truing holes in rods for knuckle bushings. These are now ground true on planetary grinders of the type shown in Fig. 5. In some cases the bushing bore is ground after the bushing is pressed into the rod. The internal grinding machine mentioned is also used for several other operations.

Driving Boxes. It was customary at one time to bore driving box brasses and afterwards spot face and file them to fit the axles. It has been found that brasses can readily be bored to correct size for the axles and eliminate filing. The best plan is to measure the axles with micrometer calipers and then bore the boxes to micrometer measurements from 0.020 to 0.030 in. larger. Experience has shown that boxes can readily be bored in this manner so that filing is not necessary.

Valve Motion Levers. When repairing valve motion levers it is often necessary to renew the bearing pins and bushings, re-ream the taper holes and true up the holes for bushings. For fitting pins and bushings satisfactory results are obtained with the 10 by 36 in. grinding machines and the internal grinder. The pins and bushings are readily blanked out to step sizes on turret lathes or automatic screw machines and placed in stock. The external bearing surface of pins and the bore of bushings are ground at the time of manufacture. When applying, the tapered

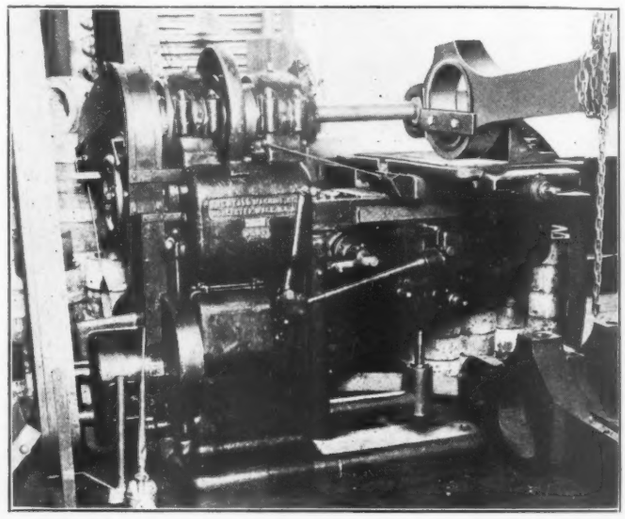


Fig. 5—Planetary Internal Grinder Truing Side Rod Knuckle Pin Hole

surfaces of pins and the outsides of bushings are ground to fit the levers. Should the holes in levers, into which the bushings fit, be out of true, they are ground true on the internal planetary grinding machine.

Guide Bars. At the present time, guide bars are almost universally finished on surface grinders, one type of which is shown in Fig. 6. With machines of this nature, guides are placed directly on the machine and ground to a true surface, no matter how badly worn. This has been found quicker than taking a rough cut on a planer and afterwards filing or grinding.

Air Compressor Pistons. Worn air compressor pistons are refinished on plain cylindrical grinding machines in a superior manner as compared to turning and filing. Air pistons, when head and rods are assembled, are awkward to hold in a grinding machine owing to the absence of lathe centers in the head end of the rod. In order to properly hold them in grinding, the machine should be equipped with a live spindle attachment which resembles a lathe head stock. With this device the piston head is held in an independent jaw chuck as in regular lathe practice, the opposite end being supported on a regular grinder center. When held in this manner the rods are quickly ground to any degree of smoothness desired. In order to swing the low pressure piston head of 8½-in. compound air compressors, it is necessary to use at least a 16-in. machine. This work, however, can readily be done on the 20-in. axles and piston rods. While this may look small for the grinder mentioned in connection with finishing locomotive machine it makes a good fill-in job.

Air Brake Internal Grinding. Good uses are made of

the planetary internal grinder (Fig. 5) for grinding cylinder bushings of triple valves, feed valves, distributing valves and, in fact, the bore of all parts subject to wear. This makes an important additional use for this machine.

Power Lapping. In order to reduce hand work, not necessarily filing, the practice of power lapping valves and valve seats of all kinds is now coming into use. There appear to be great possibilities for this method of substituting machines for hand work.

Car Work. The amount of filing required for repairs to car work is limited, the machines mentioned above being the most suitable for work in their line. Large cylindrical grinding machines can be used to good advantage for grinding car axles. However, special grinding machines have been designed for this purpose and look very promising.

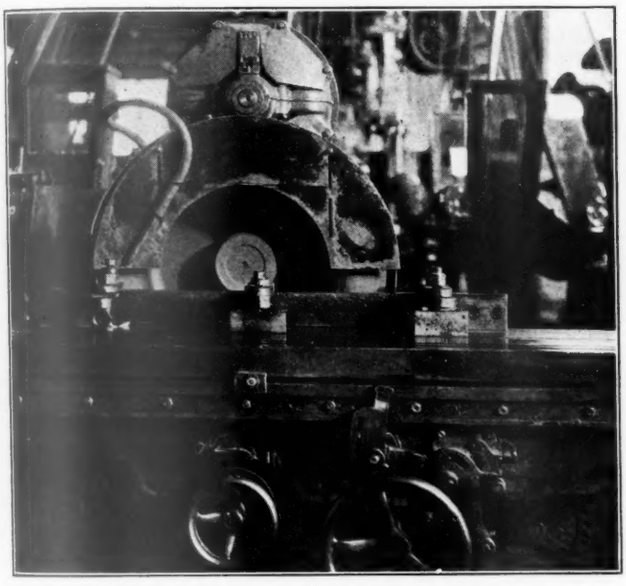


Fig. 6—Horizontal Surface Grinder Truing Worn Guide

No doubt they will be more commonly used when grinding becomes as popular in railway shops as it is now in manufacturing shops.

New Work. Most of the larger shops manufacture many new parts such as main and side rods, valve motion levers, piston rods, guide bars, and the parts fitting the same. These shops are generally equipped with slab and large vertical millers and other machines for this work. The question arises, are we finishing the articles in the most economical manner and reducing filing to a minimum? What machines should be added to increase output or reduce costs?

If the most approved practice of progressive manufacturers are followed, the file will scarcely ever be used on round work such as is turned in lathes, made on turret lathes, or automatic machines. This work will all be ground.

Flat work, such as main rods, side rods, valve motion levers, guide bars, etc., should be made principally on milling machines on which the surfaces are machined sufficiently smooth to meet all requirements, except possibly where polish is a consideration as in passenger service. In that case a swing grinder can be employed.

Main and side rods and guide bars are at present largely milled on their flat surfaces on slab milling machines. The ends and irregular surfaces are partly completed on these machines and partly on large vertical milling machines. The jaws at the present time are largely slotted, where, owing to rough surfaces, it has been customary to use a file in order to obtain the required smooth surfaces. More attention is now being paid to suitable cutters and as a result, the coming practice is to mill the rod jaws in place of slotting, as illustrated in Fig. 7, this having the advantage of producing smoother surfaces in less time. This milling is done on large vertical milling machines, or the larger vertical knee type machine.

Valve motion levers are smaller editions of main and side rods. The surfaces of the shorter levers up to 4 ft. long are readily milled on the large plain knee type milling machines, longer levers on slab milling machines, the jaws or clevises being milled from the solid. Owing to the small diameter of cutters, the surfaces are quite smooth; therefore, the file is necessary only for removing burrs.

The operations mentioned are representative but by no means complete. The machines referred to are general in character and suitable for repairs and manufacture of many other parts. When summing up it will be found that nothing radical is called for, nor any machine operation differing to a great extent from up-to-date machine shop practices.

Modern Machines Save Money

The 10-in. by 36-in. plain grinder, or machines of other sizes, are more common than lathes in many manufacturing concerns. They are used for finishing practically all cylindrical work, filing being a lost art where work can be finished by grinding. This is not owing to good looks or fancy finish, but as a plain every-day business proposition which may be put in five words, "It is cheaper and better." The same argument holds good with the large grinders. Surface grinders are now replacing planers, shapers and milling machines for all machine operations where a small amount of metal is to be removed, say 1/16 in. or less.

The planetary internal grinder is used for grinding all

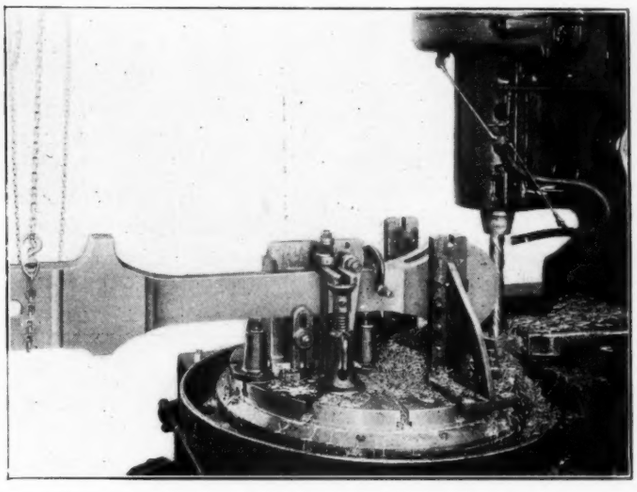


Fig. 7—Vertical Miller Machining Side Rod Fork End

kinds of internal work that cannot be revolved. Hundreds of these being used in automobile repair shops scattered all over the country. The best argument in their favor for railway work is to visit an up-to-date automobile repair shop in the home town and see the machine working.

Slab and large vertical milling machines are too common to call for special mention. The large knee type milling machine of both the horizontal and vertical types are finding their way into railway shops. These machines have sufficient strength to mill practically any locomotive part coming within their range up to the limit of the cutters. Owing to the ease of handling, a greater output for average railway work is obtained than on the slab machines. Likewise the output is much greater than by a reciprocating machine like a shaper. This is not said to cast any reflections on the slab machines or shaper, as they all have their place. Owing to the smoother surfaces, finishing after milling is rarely necessary.

Some Suggestions for Improved Shop Efficiency

Comparison of Practices and Time Studies on Different Roads Essential; Shop Schedules; Improved Personnel

By S. W. Mullinix
Supt. of Shops, Chicago, Rock Island & Pacific, Silvis, Ill.

LOOKING back to my apprentice days, I recall the wonderful opportunities of improving methods of performing various operations connected with the repair of locomotives and cars. During that period many improvements were made but we still have similar wonderful opportunities and will have in years to come, as each new year and each new lot of locomotives brings forth new problems to be met. Only by greater efficiency can we hope to keep the cost of repairing and operating locomotives within a reasonable figure compared with earning power. Important maintenance problems can be met and overcome by railroads individually, or better still by combining individual efforts, giving each the benefit of the other's experience.

I might even suggest that a number of railroads, operating under similar conditions, employ at least one capable and progressive shop man, thoroughly familiar with all departments of railroad repair shops, whose sole duty would be to study in the different shops the methods of performing various operations, recommending those which are best. It is good practice to send foremen to shops of other railroads to obtain information on shop kinks and methods of doing shop work, but the limited time does not permit these foremen to go into details, and the finer points of applied practices are not developed to any great degree.

SEVERAL striking statements of great interest and suggestive value are made in this article by a well-known railroad shop superintendent. All of our readers may not agree that it is possible to specify standard practices which will be most economical in all the repair shops of one road, to say nothing of all the shops on different roads. Of the present widely diversified practices, however, many are plainly inefficient and wasteful and should be superseded by the best modern methods. Time studies, shop schedules, machine feeds and speeds, personnel and co-operation are some of the other subjects briefly, but forcefully, discussed by Mr. Mullinix.

Such a man as suggested should be selected by the mechanical heads of the railroads which would participate in the benefits obtained, as well as in the expense of financing the move. The man's duties would be to make a careful study of the best and most economical methods of performing all classes of shop work, submitting his reports with a view to having standard practices adopted. The beneficial results would no doubt be surprising, in many cases resulting in important economies. While the above suggestion is along a new line of thought and may not be looked upon with favor by all, it seems to be a move in the right direction.

Railroad shops have as many different ways of performing work as there are shops. Surely some of these ways are wrong. In many cases it is no doubt "Do the best you can with the facilities available," and probably some shops could not take advantage of the suggestions made on account of not having the necessary or proper equipment. *They would at least have something to guide them in purchasing new equipment.* There is but one best method, for example, of machining cylinder castings. Why not study this operation in the different shops and find out just which method is most economical and practical; also what kind and size of machinery is best suited for the work. Another item is the boring, applying and turning of driving tires. Some roads bore all tires to a standard gage; others caliper each wheel center; some bore tires with a small lip or retaining ring; others bore them straight through; and many roads have different types of tire heaters. Some use crude oil; some kerosene, and others gasoline. Which is the most practical? Which one pays best in the long run?

Regarding the building up of worn or sharp flanges, each wheel shop foreman has his own idea and will surely believe he is right until shown otherwise. What is the best method of getting the centers, laying out and machining shoes and wedges? There are many ways of doing it. Which one will give the best results? When shall axles, crank pins, piston rods and other like material be consigned to the scrap heap? Some roads use "limit of wear" others use "limit of age." What method of reclaiming large axles and crank pins is the most economical?

What is the best method of reclaiming, repairing and welding flues, both large and small; threading, applying and driving staybolts; building new fireboxes? Should extra fireboxes for standard engines be carried in stock? What is the best method of repairing springs, welding frames, forging side and main rods?

There are also many smaller items, such as turning of piston rods, piston heads, crank pins, the machining of crossheads and knuckle pins. Some are made from bar stock, others forged in the blacksmith shop. What kind of material is best suited for all these various parts? Some shops use iron; some, soft steel; some, common gray iron; others brass or bronze. So why not get together and establish, so far as possible, a standard practice for performing all the various operations necessary in the repairing and maintaining of locomotives and cars. A standard bill of material for the different parts is also desirable. Something very similar to this was carried out by the Society of Automobile Engineers, which compiled what is commonly known as the S. A. E. Standards.

Comparative Time Studies Essential

Another great help would be an actual and honest comparison of the time required to perform the different operations, as nothing will spur men to greater efforts than to know that they are not up and coming with the other fellow. You may ask a man in one shop how long it takes to machine a 56-in. steel driving wheel center and he will tell you six hours; ask another on some other railroad and he will say ten hours. One may figure on merely boring a hole and rough-

ing off the outside, as some roads mount the wheels on the axles before finish turning. The other will figure the time required to finish it complete on a boring mill. Some wheels are cut out for hub liners; others are not. This all makes a difference. A 24-in. piston head may be machined complete in 48 min. and still the average production be a long way from eight heads in eight hours. What is needed is a comparison of time based on the actual performance covering a stated period. Recently we kept data on the number of driving tires turned on a wheel lathe at Silvis shops during a two weeks' period. The average obtained was 5½ pairs a day. Some railroads may be doing better than this and I know that some are not doing as well.

Good results can be obtained from a standard scheduling system for routing engines and material through the shop. Some shops have an elaborate system; others have none at all. Some standard system should be followed and whatever system is selected, it must have the support of the shop organization from the top to the bottom. A lack of co-operation is the direct cause for 90 per cent of the scheduling or routing systems proving unsatisfactory. There must be some way to get together and solve these various problems.

Are machines and equipment operating at the efficiency which the company has the right to expect? Is advantage being taken of modern machines equipped with push button control and improved gear shifting devices enabling a shifting lever to change the speed and feed on the machines? Do machine operators use these new appliances to increase production, or do they figure on doing just about so much work per day regardless of the facilities furnished them.

Among railroad employees are men who are dissatisfied with themselves, antagonistic to the company and in reality a detriment to their fellow workers. Their dismissal would be justified, yet some may be made to see the error in their attitude and in the end be made true and loyal employees. Absolute fairness on both sides will do much to foster a friendly feeling, enabling foremen and men to work in harmony.

Most railroads were certainly hard hit when so many men employed by them were classified and paid the mechanics' rate, doing work which required no special skill and which was formerly done by first-year apprentices, helpers and laborers. The larger shops were not affected as much as the smaller ones, except in the increased cost. In large shops the volume of work enabled men who became mechanics over night to be constantly employed on particular jobs in which they specialized. In the smaller shops, however, the variety of work was practically the same but the quantity much less. Therefore, the men had to work on different jobs with which they were unfamiliar.

Sometime ago while passing through the shop, I heard a crane signal by a heavy machine operator who wanted a crane to remove material from a machine. Twenty minutes' time was consumed before a crane was released and moved to handle the work. When asked if he suffered many such delays, the operator answered, "Yes," and was told to keep a record of all time lost from this cause. At the end of a month 7 hours and 20 minutes were lost. At the operator's suggestion a two-ton pneumatic hoist was installed, eliminating the lost motion there.

No doubt there are many similar conditions which can be improved. Small items which we often think are not worth while are of great aggregate importance. How often does a planer tool travel from two to six inches beyond the work and the same at the opposite end of the stroke? It would be interesting to know just how much time could be saved in the course of a year if the proper stroke were used at all times.

In endeavoring to increase speeds and feeds on various machines, the operator says, "This one casting may stand the extra speed or feed, but the next one may be hard." Speed up on the soft one and slow down on the hard one. *Just because a certain speed or feed, or method of performing some operation has been used for the past 10 years is no reason why it should be continued.*

Supervisory and Working Forces Must Co-operate

The foregoing paragraphs have indicated a few ways of improving shop practices and yet without some reference to the question of co-operation or team work, the story would be only partly told. Co-operation is just as essential in successful railroading as in any other activity.

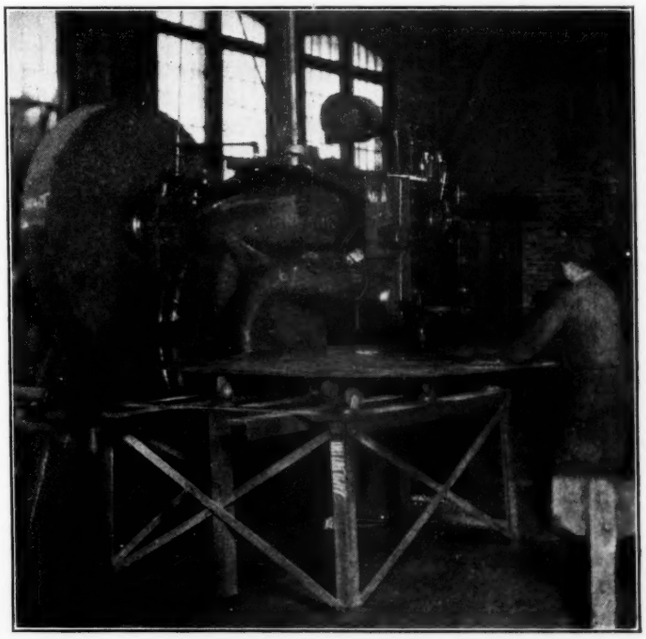
Take for example the relation of the supervisory forces to shop employees in general. What one thing could work to a greater all around advantage than real co-operation? The fact that one man happens to be a supervisor and the other a machine operator should not erect a barrier between them. They both work for the same road and should have the same general objective.

While co-operation is essential between departments and foremen, it is just as essential between the men themselves. Lack of co-operation means lost motion and works a tremendous hardship on one and all to say nothing of the direct loss to the railroad through decreased production. An improved personnel is needed. It may not be a matter of history but there was a time when men in authority criticised, found fault with and literally cussed out the men under them and fellow foremen at other points along the line. Those days have gone. Constructive criticism is all right but it must be constructive and not destructive.

For the good of each railroad there should be harmony from the president to the humblest employee. One and all should work together to the best of their ability. A shop may be strictly up to date in every way, equipped with the most modern machinery, and manned by the best of skilled mechanics but with failure to co-operate, the individual efficiency as well as the output will be seriously affected.

Ball-Bearing Casters on Punch Table Facilitate Handling Boiler Plates

A device which will save considerable labor in boiler shops and steel car shops consists of the punch table provided with ball-bearing casters as illustrated. In shops where jib or overhead traveling cranes are not available, it is customary to have several men support the outer ends of



Punch Table Equipped With Ball Bearing Casters

steel boiler plate sections while rivet holes are being punched. The labor cost for this work can be greatly reduced by means of the table illustrated which enables comparatively large and heavy plates to be handled to the punch by one or not more than two men. As shown, the table is built up of 2½-in. angle iron, braced by 1½-in. iron straps. Ball-bearing casters are firmly fastened in an inverted position on top of the table, their height being arranged so that the top of the casters is at the same elevation as the bottom punch die. This device greatly facilitates the handling of large sheet metal plates to punches and shearing machines.

The Efficacy of Annealing Overstrained Steel*

By Irving H. Cowdrey

WHY is it that anchor chains, hooks, hoisting tackle and many other iron and steel parts are periodically annealed by careful contractors and engineers? To what extent is this treatment successful in producing the expected restoration of the original properties of the parts in question? These two questions must have suggested themselves many times to the intelligent man who has been brought into contact with the commercial heat treatment plant or who has been called upon to make use of the various parts commonly subjected to the treatment under consideration. Numerous answers have been tendered in the past; some of them contain a generous portion of truth, and some, in the light of modern knowledge and ideas, are quite erroneous.

In the earlier days when steel was held to be fit for cutlery and tools alone, and nothing but wrought iron would be for a moment considered as a material for structural members, it is not at all surprising to find queer ideas concerning the constitution of these different though related products. The blacksmith nicked the iron bar, broke it across the anvil's edge and noted the stringy ragged fracture like a piece of tough hickory. Hence he held that wrought iron was essentially a fibrous material. When the piece of steel rod from which he was to forge a chisel or other like implement was broken, resulting in shiny sparking surface of coarser or finer grain he said the steel was crystalline. When the chain link parted or the hook snapped, perhaps on a cold frosty morning, showing a bright sparkling, granular texture, what was more natural than to say that the iron, which he supposed to be a fibrous metal, had by some mysterious process, crystallized. We find then such terms as cold crystallization, fatigue, etc., constantly appearing in the older literature on the subject. The advent of the microscope into the field of engineering made it possible to explain much, which had before been veiled in mystery, concerning the behavior of metals both under stress and heat treatment.

Periodic annealing has for many years been the prescribed remedy for overstrain. The question may very properly then be raised as to the efficacy of such treatment, and the extent to which metal may be overstrained and still be restored by annealing. While it has been admitted by most engineers that the effect of slight over strain may be in part, if not wholly, removed by annealing, yet there have been a certain number who have held that very excessive distortions produce results which cannot be nullified by such treatment. Moreover many have declared annealing to be completely effective only for the very lowest carbon steels. To prove or disprove this stand, a set of tests was lately conducted at the suggestion of the writer in the testing materials laboratory of the Massachusetts Institute of Technology.

The material selected was a 0.20 per cent carbon steel with the normal content of silicon, manganese, sulphur and phosphorus. This was purchased as hot rolled steel 1½ in. in diameter and about 7 ft. long. From this tensile test specimens were fabricated to determine its physical properties as received and also after careful annealing. The remainder of the bar was then subjected to torsion, and twisted cold until fracture was produced. From the over strained material, tensile specimens were taken which were tested in this cold worked condition and also after having been carefully annealed. The Brinell hardness was determined under all the various conditions and photomicrographs were made to study the structure of the metal. At least two specimens were tested in each case and in every instance the values checked admirably. All tensile specimens conformed to the dimensions of the U. S. standard test bar having a 2-in. gage length and a 0.505 in. diameter with threaded ends and were tested in a universal autographic testing machine of 60,000-lb. capacity. Such a method of testing does not permit the determination of the true elastic limit. That the properties of the material were determined under tension while the over strain was produced in torsion may seem paradoxical. Such, however, is not in reality the situation since, according to Upton all permanent distortion is a result of internal shear regardless of the actual external loading. As a matter of fact it is probable that over strain by such a means is more severe than when the specimen is stressed axially, since fissures, if produced, will be inclined to the axis of the subsequent tensile specimen. While of no special significance, it may, however, be of interest to note that the bar as received, twisted through nearly 16¾ complete turns in a length of 4½ ft. or nearly 3¾ turns per foot of length.

The annealing was done in accordance with one of the two following methods which will be designated as Treatment I, and Treatment II respectively.

I. Specimen wrapped in carbon and asbestos, heated for one hour at 1,760 deg. F. and air cooled.

II. Specimens packed with cast iron chips in a loosely closed tube, heated at 1,760 deg. F. for 1½ hours and air cooled. The first method gave considerable surface oxidation, while the specimens treated by the second method showed no discoloration whatever. The results of the above tests appear in the following tabulation. The values in each instance are the averages of at least duplicate tests.

TABLE I

	Results of Tensile Tests				
	Yield Stress lb. per sq. in.	Ultimate Stress lb. per sq. in.	Elong. per cent	Red. Area per cent	Brinell No.
Bar as received.....	46,000	67,850	35.7	64.4	131
As received plus Heat Treatment I.....	40,000	68,250	33.7	62.5	130
Twisted Bar.....	86,500	95,633	15.8	54.3	180
Twisted Bar plus Heat Treatment I.....	42,200	67,200	36.5	62.5	128
Twisted Bar plus Heat Treatment II....	43,150	69,450	37.0	62.0	127

The various data will now be analyzed and discussed. Throughout the discussion it should be kept clearly in mind that it is in general impossible to obtain perfect checks in the testing of any material whatever. With very homogeneous steels variations of several per cent must be expected even when tests are conducted on adjacent specimens. Hence variations of two or three thousand pounds per sq. in. in yield stress and ultimate stress and one or two per cent in elongation and reduction of area are entirely negligible, within the above limits, then, there is perfect agreement between the figures in the first two and last two rows. Among other things this would indicate that the material was very well annealed when purchased. The results recorded in the center row showing properties after cold twisting are of an

*Abstract of a paper presented before the Indianapolis Convention of the American Society for Steel Treating. The author, Irving H. Cowdrey, is assistant professor testing materials, Massachusetts Institute of Technology, Cambridge, Mass.

entirely different order. The yield stress has been doubled while the tensile stress and hardness have been increased about one-half. On the other hand, the ductility is less than half that evidenced by the normal metal. This difference is entirely in accord with results obtained from tests on cold worked material in general, such as cold rolled steel, extruded metal and wire provided the material is of such dimensions and so fabricated that the effect of cold working has penetrated well into the interior. With the increased hardness and decreased ductility it would seem obvious that the metal is in a state quite unsatisfactory for resistance to shock even though its static strength has been increased. Overstrained hooks, chains and-so-forth, have suffered alteration in their physical properties along just such lines as this, the difference being solely one of degree. As before intimated, the last two rows show that the original properties have been completely restored by the heat-treatment to which the steel was subjected.

As a result of the foregoing theory, description and analysis the following conclusions are in order.

1. Overstrain of metal when its temperature is below the transformation range, results in the production of undesirable properties tending to render the metal unfitted to withstand sudden and shock loads. 2. If possible such effects should be eliminated for the safety of those using devices which have been so abused. 3. Proper annealing suffices to completely restore the normal properties of low carbon steel even after the most severe over strain.

Pneumatic Power and Transmission Losses

Part Two, Dealing with Losses in Compression; Indicator Cards a Valuable Means for Checking Results

By B. C. Bertram
General Locomotive Inspector, Erie, Youngstown, Ohio

This is the second installment of an article of particular interest to railroad shop and power plant men in view of the present coal shortage and necessity of conserving fuel in every possible way. With excess compressor capacity, air leaks do not seriously interfere with the operation of pneumatic tools and devices. The result is that such leaks do not generally receive prompt attention. Many leaks in underground and inaccessible lines are never discovered and through the coal pile cause a constant drain on railroad resources. This article was begun on page 529 of the September number, the first installment being devoted to a detailed study of methods for locating and stopping air losses common in railroad shops and yards. As explained editorially in the September number, the air losses described are typical of those which may be found in almost any railroad shop and which should be corrected by some such means as those indicated.—Editor.

PROPER care and maintenance of air compressors is of vital importance. There are few machines as universally abused, being operated in many instances 24 hours a day with necessary repairs frequently deferred until the machines become practically inoperative.

In purchasing an air compressor, present requirements should never be considered as a basis in estimating the capacity of the machine required. Future needs should be anticipated. In most cases the demand for compressed air outgrows the capacity of the initial compressor installation within a comparatively short time. As a rule, however, the necessity for additional compressor capacity can be obviated by applying exact and systematic methods in stopping and preventing air leakage due to defective transmission lines and by rectifying certain other defects, thereby increasing the capacity of the compressors. It is not uncommon to find that only 50 per cent efficiency is being obtained from compressors due to some internal defects which continue to be unnoticed by power plant engineers or others in supervisory capacities.

To ascertain whether an air compressor is delivering its maximum capacity, an orifice test should be made. This may be accomplished by shutting off all lead lines from the air receiver, making sure that valves in the line do not leak, and screwing a plug provided with a sharp edge circular orifice into the drain pipe connection at the bottom of the receiver. For example, in the case of a compressor having a capacity of 1,000 cu. ft. per min. at 140 r.p.m., a ¾-in. orifice should be used, the compressor being run at 100 r.p.m. and the pressure maintained in the receiver at that speed carefully noted.

The amount of free air displaced each revolution by the compressor can be readily computed from the piston diameter and length of stroke, being in this case approximately 7.14 cu. ft. At 100 r.p.m. the compressor would be expected to displace 714 cu. ft. per min. If, therefore, it was found that the gage registered only 50 lb. at this speed with the ¾-in. orifice open, it will be seen from Table I that the compressor is only displacing 521 cu. ft. per min. while it should have displaced 714 cu. ft. It will then be apparent that the compressor is only a little more than 75 per cent efficient, due to some defects in the air end.

To figure the theoretical capacity of an air compressor, it is simply necessary to find the piston displacement in the low pressure cylinder and multiply by the number of revolutions per minute at which machine is being operated.

To ascertain the number of cubic feet of free air contained in an air receiver filled with compressed air, multiply the pressure of the air by the corresponding multipliers shown in Table II. This result multiplied by the cubic contents, or number of cubic feet contained in the receiver, will give the number of cubic feet of free air.

Indicator Diagrams Prove Invaluable

In testing for various air compressor defects, the steam engine indicator has proven of inestimable value and some of the revelations made by the indicator diagrams have been startling.

Facsimiles of actual indicator diagrams, showing the effect of varied defects in the cylinders of air compressors, are introduced in this article and each represents a condition which actually existed and some of which undoubtedly exist at present in compressors in many other railroad shops or

wherever considerable attention has not been given these matters.

Fig. 1 is a reproduction of an indicator card taken from the low pressure air cylinder of a compressor employing the ring type intake valve in the piston. The diagram clearly indicates that the valve ring was sticking and it will be noted

Fig. 1

that compression in that particular end of the cylinder did not start until the piston had advanced half way on its stroke.

Investigation revealed that the cause of this defect was the use of heavy oil as a lubricant, causing carbon deposits and dust to accumulate on the piston, cylinder heads and in the air passages. Only a light oil with a comparatively high flash point should ever be used in air cylinders and even light oil should be used sparingly. Six drops a minute is usually sufficient.

Fig. 2 is a reproduction of the indicator diagram taken

Fig. 2

from the same cylinder after deposits had been removed and the valve made to operate freely. This defect alone decreased the efficiency of the compressor more than 25 per cent.

The compressor referred to was being operated 24 hours a day to supply air to a large roundhouse and car yard. The bore of the cylinder being 25 in., the stroke 16 in. and speed 140 r.p.m., the loss of air occasioned by this defect on each stroke was approximately 1.136 cu. ft., or 159.04 cu. ft. per min., or 229,008 cu. ft. per day. This defect was also principally responsible for the fact that insufficient

Fig. 3

pressure amounting to only about 50 lb. was all that could be obtained. After the defect was remedied, a pressure of 100 lb. was easily maintained, resulting in a corresponding increase in the efficiency of all air tools being used in the shops.

Another great loss in compressor efficiency is illustrated in Fig. 3, which is a reproduction of an indicator card taken from a low pressure air cylinder in which new type plate valves were substituted for the old poppet type. In this instance the valve cage seats had been re-cut several times to

Fig. 4

re-establish a perfect seat for the cage and in so doing, so much metal had been removed that when the new type valves were installed, they did not clear the piston. Each time the piston advanced it came in contact with the valve cage, forcing it off its seat and allowing air to bypass the valve unit. The effect is clearly shown in Fig. 3. The contrast after the defect was remedied is shown in Fig. 4. Most compressor manufacturers furnish an extra slip ring to meet the above mentioned condition.

Table I—Volume of Air (Cu. ft. of free air per min.) That Will Flow Through Round Holes in a Receiver Into the Atmosphere

Diameter of Orifice Inches	GAGE PRESSURES IN RECEIVER—POUNDS																													
	2	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	125	150	200	
1/64	.038	.0597	.0842	.103	.119	.133	.156	.173	.19	.208	.225	.26	.295	.33	.364	.40	.486	.57	.76	
1/32	.153	.242	.342	.418	.485	.54	.632	.71	.77	.843	.914	1.05	1.19	1.33	1.47	1.61	1.97	2.33	3.07	
3/64	.342	.545	.77	.94	1.07	1.21	1.4	1.56	1.71	1.91	2.05	2.35	2.68	2.97	3.28	3.66	4.12	5.20	6.9	
1/16	.647	.965	1.36	1.67	1.93	2.16	2.52	2.80	3.07	3.36	3.64	4.2	4.76	5.32	5.87	6.45	7.85	9.20	22.2	
3/32	1.37	2.18	3.06	3.75	4.28	4.84	5.6	6.24	6.84	7.6	8.2	9.4	10.7	11.38	13.1	14.5	17.5	20.8	27.5	
1/8	2.435	3.86	5.45	6.65	7.7	8.6	10	11.2	12.27	13.4	14.5	10.8	19	21.2	23.5	25.8	31.4	36.7	48.7	
3/16	5.45	8.72	12.3	15	17.1	19.4	22.4	25	27.4	30.4	32.8	37.5	42.9	47.5	52.4	58	70	83.2	110	
1/4	9.74	15.4	21.8	26.7	30.8	34.5	40	44.7	49.09	53.8	58.2	67	76	85	94	103.2	125.5	147	195.8	
5/16	21.95	34.6	49	60	69	77	90	100	110.5	121	130	151	171	191	211	231	282	330	440	
3/8	39	61.6	87	107	123	138	161	179	196.4	215	232	268	304	340	375	412	502	588	782	
1/2	61	96.5	136	167	193	216	252	280	306.8	336	364	420	476	532	587	645	785	920	1220	
5/8	87.6	133	196	240	277	310	362	400	442	482	521	604	685	765	843	925	1127	1322	1760	
3/4	119.5	189	267	326	378	422	493	550	601	658	710	822	930	1004	1145	1260	1161	1804	.....	
7/8	156	247	350	427	494	550	645	715	786	860	930	1070	1215	1360	1500	1648	2000	2350	.....	
1	196	310	440	538	620	692	812	900	987	1082	1170	1350	1530	1710	1890	.....	.....	.....	.....	
1 1/8	242	384	543	665	770	860	1000	1120	1230	1345	1455	1680	1900	2130	2350	.....	.....	.....	.....	
1 1/4	291	464	660	803	929	1040	1200	1350	1480	1630	1760	.....	.....	.....	.....	.....	.....	.....	.....	
1 3/8	350	550	780	960	1102	1240	1435	1600	1700	1930	2085	.....	.....	.....	.....	.....	.....	.....	.....	
1 1/2	473	752	1068	1304	1505	1680	1960	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
2	625	985	1395	1700	1967	2200	2586	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

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In another very large compressor employing plate type valves of about 10 in. diameter, it was found that new valves which had been applied bottomed in the recess of the valve chamber and were, therefore, prevented from making a proper seat on the copper gasket provided for that purpose. This also allowed air to bypass the valve cage and investigation developed that a loss of approximately 20 per cent of compressor efficiency resulted from this defect. In both the foregoing instances the shop line pressures were greatly increased and the revolutions per minute of the compressors considerably reduced by correcting the defects.

All leading manufacturers of air compressors are now employing the plate type valves which have proved a great improvement over the old poppet type. Old compressors still using the poppet type valves should be equipped with the new valves at the earliest opportunity since they add materially to the efficiency of the compressor.

Table II—Multipliers for Transforming Volumes of Compressed Air at Various Pressures into Corresponding Volumes of Free Air at Atmospheric Pressure of 14.7 Lb.

Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier
1	1.068	26	2.768	51	4.469	76	6.170	101	7.870
2	1.136	27	2.836	52	4.537	77	6.238	102	7.938
3	1.204	28	2.904	53	4.605	78	6.306	103	8.006
4	1.272	29	2.972	54	4.673	79	6.374	104	8.074
5	1.340	30	3.040	55	4.741	80	6.442	105	8.142
6	1.408	31	3.108	56	4.809	81	6.510	106	8.210
7	1.476	32	3.176	57	4.877	82	6.578	107	8.278
8	1.544	33	3.244	58	4.945	83	6.646	108	8.346
9	1.612	34	3.312	59	5.013	84	6.714	109	8.414
10	1.680	35	3.380	60	5.081	85	6.782	110	8.482
11	1.748	36	3.448	61	5.149	86	6.850		
12	1.816	37	3.516	62	5.217	87	6.918		
13	1.884	38	3.585	63	5.285	88	6.986		
14	1.952	39	3.653	64	5.353	89	7.054		
15	2.020	40	3.721	65	5.421	90	7.122		
16	2.088	41	3.789	66	5.489	91	7.190		
17	2.156	42	3.857	67	5.557	92	7.258		
18	2.224	43	3.925	68	5.625	93	7.326		
19	2.292	44	3.993	69	5.693	94	7.394		
20	2.360	45	4.061	70	5.761	95	7,462		
21	2.428	46	4.129	71	5.829	96	7.530		
22	2.496	47	4.197	72	5.897	97	7.598		
23	2.564	48	4.265	73	5,965	98	7.666		
24	2.632	49	4.333	74	6.033	99	7.734		
25	2.700	50	4.401	75	6.102	100	7.802		

Formula $\frac{1}{14.7} \times \text{Pressure} + 1 = \text{Multiplier}$

Atm. Pres.—14.7 lb. Barom. Pres.—30 in. Temp.—60 Deg. F.

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Additional Defects Shown by Diagrams

The indicator is also valuable in locating broken or defective cylinder packing, broken or leaking valves and for setting mechanically operated air valves. Its use in correcting the setting of steam valves is more common than for locating air troubles.

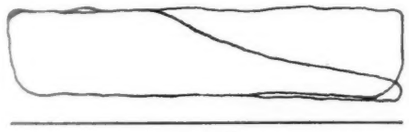

Fig. 5

Figs. 5 to 10 are reproductions of diagrams taken from steam cylinders of several air compressors employing Corliss and Myer valve gears. Fig. 5 shows a diagram from a Corliss valve which, on account of certain defects, was not tripping, live steam being used the entire length of the stroke. Fig. 6 shows the diagram taken from the same cylinder after the correction was made.

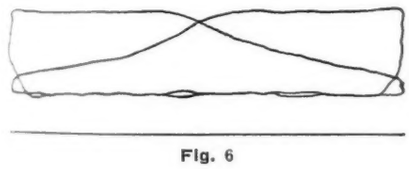

Fig. 6

Fig. 7 was taken from the high pressure steam cylinder of a compound compressor. In this case the engineer of his own volition had reset the eccentrics in order to operate the machine in an opposite direction from which it was designed to run, stating that it ran quieter in that direction. The main and cut-off cams were turned from a solid casting. In slipping the eccentric back, the desired lead could be obtained on the main valve cams only, and when this was done, due to the fixed angularity between the main and cut-off cams, the cut-off cams were opposite the position which they should have assumed in a correct setting of the valves.

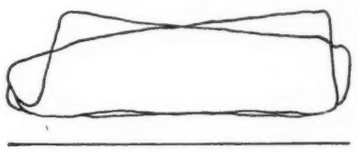

Fig. 7

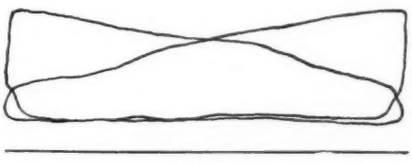

Fig. 8

The distortions shown in Fig. 7 will indicate the efficiency losses resulting from this defect, and present a marked contrast with Fig. 8, which shows a card taken from the same cylinder after the valves had been reset to operate the machine in the proper direction. It will be noted from Fig. 7 that all port events were greatly deferred.

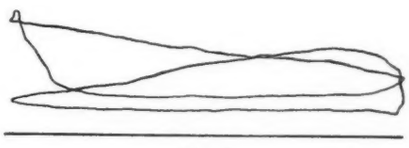

Fig. 9

Figs. 9 and 10 are reproductions of indicator cards taken from the steam cylinders of compressors in actual service in railroad shops in different parts of the country, their distortions indicating many and varied defects.

While the foregoing illustrations present some rather unusual cases, yet they are not at all uncommon, and any of these conditions may exist for long periods of time, costing many thousands of dollars each year and continuing unnoticed unless concerted action is taken to detect them. In many instances steam valves have not been reset in years.

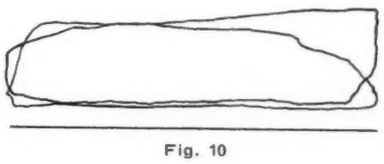

Fig. 10

Valves Set Every Six Months

A good practice is to check the valve setting every six months or more often, either by use of the indicator or by removing the steam chest cover and making the adjustments necessary. Cut-off adjusters should always be kept free from corrosion and in working condition to facilitate the resetting of the valves.

In connection with the testing for defective air valves, it

is advantageous to have globe valves applied to indicator taps in air cylinders. By stopping the compressor when the pressure is pumped up and opening these globe valves, the high pressure discharge valves can be tested for leaks, for it is obvious that all the air emitted from the globe valves has leaked past the discharge valve.

The setting of mechanically operated air valves should be checked up at frequent intervals since it must be remembered that adjusting or keying up of the shackle (sometimes called stub end) bearings on valve rods, changes the travel of the valves.

Suggestions for Improved Compressor Operation

Poppet type valves should be inspected and cleaned every 30 days.

Globe valves applied at the indicator taps in the steam cylinder will permit of the testing for a leaky throttle, worn or broken cylinder packing or leaking steam valves.

Excessive water in air lines and receivers may be caused by defective cylinder head gaskets or leaking intercooler tubes. These defects may be detected by observing the overflow from the water jackets. If there is any communication from the water chambers into the cylinder or other air spaces, the stream of water from the overflow will be greatly disturbed and irregular.

Wherever the overflow water is piped to a water heater or for any reason there is liable to be a slight back pressure in the overflow line, the circulation is liable to be interrupted, preventing proper cooling of the cylinders.

Water jackets should be cleaned out at frequent intervals.

In case of a defective front cylinder head gasket, the trouble can be eliminated easily by applying a dovetailed gasket and if care is taken in its application, it will be just as permanent as a solid gasket.

Knocks in the air compressor may be caused by any of the following defects: Lost motion in crank pin, crank shaft or wrist pin bearings; crosshead gibs loose on crosshead; crosshead gibs adjusted too tightly (this will cause a severe knock); crosshead too loose in guides; piston loose on rod; piston striking cylinder heads; flywheel loose on crank shaft and end play in mechanical valves. The latter defect may be overcome by inserting a fibre washer between the end of the valve and the valve bonnet, care being taken to see that the valve operates freely.

If the flywheel is loose on the crank shaft, it can be remedied by inserting a thin sheet of tin between the crank shaft and the bore of the wheel. Care should be exercised to see that the shim extends the full width of the hub to prevent the wheel from running out of true.

In tightening piston rod packing, care should be taken to draw up evenly on the packing gland so as not to score the piston rod.

Lubrication System Must Be Kept Clear

Where a force feed lubrication system is used, the pipes should be blown out at regular intervals as bearings are frequently burned out caused by oil pipes becoming stopped up and preventing oil from reaching the bearings. Except in the case of the enclosed crank case type compressors, gravity sight feed oil cups are usually found to be more satisfactory than the force feed system.

Frequently there is no air gage on a compressor to indicate the first stage pressure in the receiver or intercooler. It is of vital importance that compressors be equipped with a gage in order that this pressure can be noted at frequent intervals, since by this method any irregularity or defect to any of the air valves will become instantly noticeable. The correct pressure in the receiver or intercooler between the high and low pressure air cylinders of a two stage compressor varies slightly with different types and makes of machines, but is usually from 23 to 30 lb. Any variation from these figures invariably denotes some sort of an air valve defect.

It is also of great importance to see that governors are functioning properly. Frequently it is found that governors are improperly adjusted or out of commission entirely. Air compressors should never be controlled by the method of hand throttling, as it is found that in these cases, air pressure usually varies directly with the steam pressure as there is no action of the governor to compensate for the varying steam pressure. Also, when the air pressure increases, the compressor will run slower and the desired pressure is seldom obtained. To successfully operate an air compressor by hand throttling, would demand constant attention on the part of the engineer, which is practically impossible and is seldom, if ever, given.

Operate Compressors at Rated Speed

It is highly important that engineers understand at what speed the compressor is designed to operate. Instances have been known where, due to an erroneous opinion of the engineer, compressors have been operated at a much lower rate of speed than they should have been, with the result that an insufficient pressure was maintained on the shop lines. Many engineers are of the opinion that 75 or 80 lb. is a sufficient pressure to operate the shop tools. This is not sufficient, however, and there is no excuse for insufficient air pressure as long as compressors are not operated up to speed. The old time idea that a good engineer is one who, by operating his compressor slowly and cautiously, makes it last for many years at the expense of the shop line pressure has given way to the more modern idea that the good engineer realizes that there are just so many units of power in his machine. He sees to it that the maximum pressure is constantly maintained even though it becomes necessary to operate the compressor at its maximum speed, thereby preventing thousands of dollars' loss in production each year, a sufficient amount in some instances to buy several new compressors.

Another matter of importance is to see that the flywheel does not run out of alinement. If it does, it sets up a stress on the crank shaft when it is rapidly rotated, sometimes severe enough to break the crank shaft. In any event, it detracts from the smoothness of the running of the machine as well as causing a loss of power.

A flywheel can easily be trued by the method of piening the spokes as near the hub of the wheel as possible. The principle of this operation is that by compacting the molecules of iron, the side of the spoke being piened is elongated and throws that portion of the rim of the wheel directly above it into alinement. In undertaking an operation of this kind, care should be taken not to throw the rim too far. Between piening operations the wheel should be rotated and marked with chalk similar to the method employed in setting up a piece of work in the chuck of an engine lathe.

The air line to the gage indicating storage reservoir pressure should be run directly from the reservoir and not tapped into the discharge line as is frequently done. By tapping into the discharge line close to the compressor, the gage hand is caused to pulsate and besides being injurious to the gage, a correct reading cannot be taken. Also the air regulator of the governor is generally actuated by the pressure in the gage line and the pulsations interfere with its proper regulation.

Reduce Idle Running Time If Possible

It is frequently found that compressors driven with constant speed motors and employing automatic pressure control or unloading devices usually run idle the greater portion of the time, especially in car yards or wherever the demand for air is comparatively small. While the machine is running idle, it is consuming electric power as well as uselessly wearing out the compressor.

One specific instance was in the case of a compressor oper-

ating at a speed of 270 r.p.m. It was cut in only one minute out of fourteen, and as this machine was located in a car yard where it was necessary to maintain the pressure night and day, the machine was operated constantly. The loss in this particular case is very apparent. In instances of this kind, the ratio between the drive pulleys or gears on the motor and compressor should be increased in order to decrease the speed of the compressor until its capacity more nearly equals the demand for air.

It has been found much more satisfactory to employ variable speed motors or equipment employing an automatic cut-out to stop and start the motor when air pressure rises or falls below the desired pressure. The first cost of such installation is higher, but it is a great economy in the long run.

Principles of Oxyacetylene Fusion Welding Part 6—Welding Cast Iron, Continued

By Alfred S. Kinsey*

THE five chemical elements in cast iron have their own peculiar influences on the metal as may be seen by the following:

Carbon. When a welder gets cast iron in the molten condition he has affected the carbon to such an extent that it is all of one form and entirely absorbed by the pure iron. But when the molten iron solidifies, some of the carbon stays combined with the pure iron and is called combined carbon, while the remainder of the carbon stays free of the iron and is sometimes called free carbon, but as it is of the nature of graphite like the lead of a pencil, it is more often called graphitic carbon. It is the amount of these two carbons and their proportions to one another which makes cast iron hard or soft, strong or weak.

Improvised Preheating Furnace for Cast Iron Welding

Now the amount of carbon which remains combined and that which becomes graphitic depends on the way the welder allows the iron to cool. If it cools fast, most of the carbon will remain combined with the iron and the cold casting will be so hard it cannot be machined. On the other hand, very slow cooling will allow the proper amount of combined carbon to be released from the pure iron and become graphitic carbon, which will give the casting the degree of softness it was intended to have.

There is also another characteristic of carbon which the welder must consider, and that is that it will burn. When cast iron is melted with a welding torch some of the total carbon burns out, the amount varying from 0.2 to 0.5 per cent of say the 4 per cent in good cast iron. This loss depends on two things in welding, first on the nature of the flame of the torch. If it is a carbonizing flame, the loss of carbon from the iron would be largely prevented by the acetylene of the flame. Second, if the iron casting is being preheated by charcoal, the molten metal will absorb carbon from the charcoal and the loss of total carbon would be much less. Here is the main reason why iron castings to be welded should be preheated in a charcoal fire. It is therefore probable that in most cases of the welding of cast iron with the proper torch flame and preheating gases the loss of total carbon from the iron is not more than 0.10 or 0.20 per cent. However, if the torch works with an oxidizing flame and the preheating is done with a non-carbonizing heat the loss of total carbon from the molten iron may run as high as 1.00 per cent, which would make the weld hard and brittle. Then if the job was interrupted and allowed to cool and be reheated two or three times, the loss of carbon would be much greater, and the weld would be ruined.

Pure iron can absorb as high as about 4.6 per cent of total carbon.

Silicon. This element is absorbed by the iron, that is, it is not between the grains but is soaked up by and becomes part of the grains of pure iron. Silicon is valuable in cast iron as a sort of governor of the carbon. Every time a welder melts a piece of cast iron there is a loss of about .25 per cent of the usual 2.50 per cent of silicon, and as the total amount of silicon decreases it causes the combined (hardening) carbon to increase and the graphitic (softening) carbon to decrease, which leaves the metal harder each time. So that a welder should be careful to make as few melts as possible in completing a cast-iron weld.

Manganese. This chemical element is used in cast iron to avoid shrinkage and gas troubles in the finished casting. The amount of manganese usually runs from .50 to .70 per cent. If the amount falls below .50 per cent, the casting will be liable to shrink unevenly and form cracks. Now every time cast iron is heated from the solid to the molten condition it loses about .10 per cent of its manganese. So that if a welder was busy on a casting which contained an average of .60 per cent manganese and he remelted a couple of times, he would demanganize the iron below the safe limit of .50 per cent and shrinkage cracks would be liable to occur, even though the job was carefully covered and unheated very slowly.

Manganese assumes two forms in cast iron. In one it com-

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bines with the sulphur and assists in removing that harmful element. In the other form manganese absorbs the oxygen and prevents oxides from forming in the iron. In the right proportions manganese becomes part of the grains of pure iron and combines with the carbon and thereby completes its beneficial influences on cast iron.

Phosphorus. The first thing to remember about phosphorus is that it makes cast iron hard and brittle. But it is also true that it will make molten cast iron more fluid and thereby cause it to flow easily and be useful in the making of castings having very fine details. While pure iron will absorb 1.70 per cent of phosphorus, the amount of this element in cast iron should not exceed 0.70 per cent and the usual figure is from that down to 0.20 per cent.

Sulphur. This element is a dangerous one to cast iron, as its tendency is not only to make the metal hard, separating the grains and weakening the whole structure, but every time the iron is melted the amount of sulphur is increased instead of being decreased as in the case of the other elements. Now of course a welder is not likely to add sulphur to the cast iron as he welds with an oxyacetylene torch, but if he preheats the casting as is customary, the charcoal or coke fuel will contain sulphur which will be absorbed by the molten iron. This will not be so detrimental if the sulphur in the iron at first is kept as low as 0.05 per cent, which is the amount to be found in good quality cast iron. The sulphur content should not go over 0.12 per cent.

In detailing the characteristics of the five chemical elements and their influence on cast iron we have had in mind to impress upon the welder: (1) That there are some simple physical laws which govern the melting of cast iron, as in the making of a weld; (2) that the best welds can be made by the welder who understands the influences of these chemical elements and respects them; (3) that the oxyacetylene flame can largely control the influences of these elements and produce a satisfactory weld.

Physical Nature of Cast Iron

We have seen how cast iron is influenced by its chemical ingredients, now let us consider the typical physical characteristics of the metal.

Growth from Heating. Cast iron will increase in length and breadth every time it is heated red hot and allowed to cool. That is, when a welder heats a piece of cast iron red hot it expands and then when it gets cold it contracts, but the contraction is never as much as the expansion, so the size of the casting gradually increases in all directions, until finally after many heatings the grain structure of the metal breaks down, cracks are formed and the casting is spoiled. To get this growth the iron does not need to be heated as high as the melting temperature, as the greatest rate of growth occurs at a red color which is at temperatures between 1,400 and 1,600 deg. F.

The growth of cast iron probably is due to the oxygen from the air getting between the grains of the pure iron when hot and forming iron oxide, or scale. Such oxides, gradually increasing in size, spread the grains apart and thus enlarge the casting. It has been found by long experiments that cast iron can be made to grow as much as 45 per cent in volume and 15 per cent in length.

Of course a welder will not only be interested in this physical characteristic of cast iron, but he also will see the application of the knowledge of his work. If he heats a casting to the red color as is usually done for preheating and allows it to cool, and then repeats this before completing a weld, he may expect the original size of the casting to be increased each time it is reheated, and at the same time the iron will become weaker and spongy. In a locomotive cylinder, for example, this growth might be irregular enough to throw the cylinder bore out of round and make it oval in shape, and the straight parts of the casting may be thrown out of line, or warped. The simple rule to follow is to get the welding done as soon as possible after the casting is preheated to the right temperature.

Fluidity. The melting point of cast iron varies with the quality of the metal, it being about 2,200 deg. F. for the gray cast irons like Nos. 1, 2 and 3, and about 2,000 deg. F. for the white cast irons like Nos. 4 and 5. Now it is to be noted that this is the *melting* point of cast iron; that is, the temperature at which the iron changes from the solid to the liquid condition, but it is not the *welding* temperature of cast iron. The molten metal should be superheated; that is, heated about 200 deg. F. hotter than the melting temperature. This will give the necessary fluidity to the metal to allow the grains of the two ends being welded and the welding rod to run together, fusing into one solid piece.

Of course a welder would have no accurate means of measuring the temperature of the molten iron in order to secure the 200 degrees of superheat, but a little practice in melting cast iron with an oxyacetylene torch will enable a welder to see the difference between dull liquid iron and

Welding 8½-In. Cross Compound Air Compressor Head

superheated or hot liquid iron as it is called in foundry practice. Under the torch flame, dull liquid iron has the appearance of motion, like thick coffee, for example, while hot liquid iron flows as freely as clean water.

Now the chief physical difference between hot and dull iron is the attractive power of the grains of the metal. In the cold, solid condition of cast iron it would take about 20,000 lb. per sq. in. to overcome the power of attraction, and this is gradually reduced as the metal is heated until at the dull liquid state the attractive power is probably only a few ounces per sq. in., and at the hot liquid condition all of the attractive power is just about gone, and the grains will separate very easily. But if they do the air will enter and the surfaces of the grains of iron will be coated with iron oxide so that the metal will be *burnt* and ruined.

The welder will therefore see first the importance of welding cast iron with the metal in the superheated condition, and second, the necessity of not overheating the metal and thereby entirely destroying its plasticity.

Freezing Point of Cast Iron. We have written of the change in cast iron by the raising of its temperature from that of the cold, solid condition to that of the hot molten state, and we have noted the importance of making such a change with consideration of the physical nature of the

metal. Let us see what happens when a piece of cast iron is unheated, that is cooled under control.

The freezing point of cast iron is the place at which the metal sets or changes from the liquid to the solid condition. It is not the same as the melting point. For example, if the melting point of a good gray iron is 2,250 deg. F., the freezing point will be about 2,100 deg. F. This difference between the melting point and the freezing point is known to the foundryman as the *life* of the metal, and the success of the making of an iron casting depends on the length of its life. This also is of much importance to an oxyacetylene welder, for if the life of the metal is normal the possibilities of obtaining a good weld are excellent. Now the first thing air will do to molten cast iron is to raise its freezing point and thereby shorten its life. Then the metal will set so quickly that its fusion or running together will be poor and the weld will be unsatisfactory. Of course it may therefore be seen that the welder should not allow the molten metal to be attacked by the air and become oxidized, if he expects to keep it under control while making a weld.

Gray cast iron has the highest melting temperature and the lowest freezing point, which make it have a longer life than the white cast irons, and this to the welder means that the soft gray irons will weld easier than the hard white irons.

Before starting to weld cast iron try it with a file. If it does not file easily the welder will know that it has a short life, and he will have to weld quickly and be very careful of the molten metal freezing or taking *sets* as he goes along. If such sets should occur, they will form a *cold shut* in the metal, which is two masses of molten iron partly solidified and run together. They make an imperfect junction, sometimes shown by deep lines on the surface of a casting, and cause the metal to be so weak that it may easily be broken apart by a moderate blow or jar.

The Chill of Cast Iron. By this term is meant the nature of cast iron to get hard on its surface when as molten metal it is cooled at a rapid rate. For example, if some molten cast iron were poured into a mold made of cold iron instead of the common sand mold, it would become solid very quickly wherever it came in contact with the cold iron mold, and that part of the casting would also be so hard it could not be filed or machined. At the same time the remainder of the casting would be of soft iron. This difference of the hardness and softness of the same casting is called the *chill.*

What really happens to produce the chill is that when the cast iron is melted its carbon is all in the form of combined carbon which, if allowed to cool slowly as in sand molds, would nearly all gradually change back to graphitic carbon. But if the molten metal is cooled quickly, practically all of the carbon stays as combined carbon and as this is the hardening carbon of cast iron the metal is changed from a soft gray iron to a white iron, chilled to a hard state.

The depth of this chill from the surface down into the metal chiefly is governed by the amount of silicon in the iron. With about 1.00 per cent silicon the iron may be chilled ½ in. deep, while with 0.10 per cent silicon the chill would go in 3 in. deep.

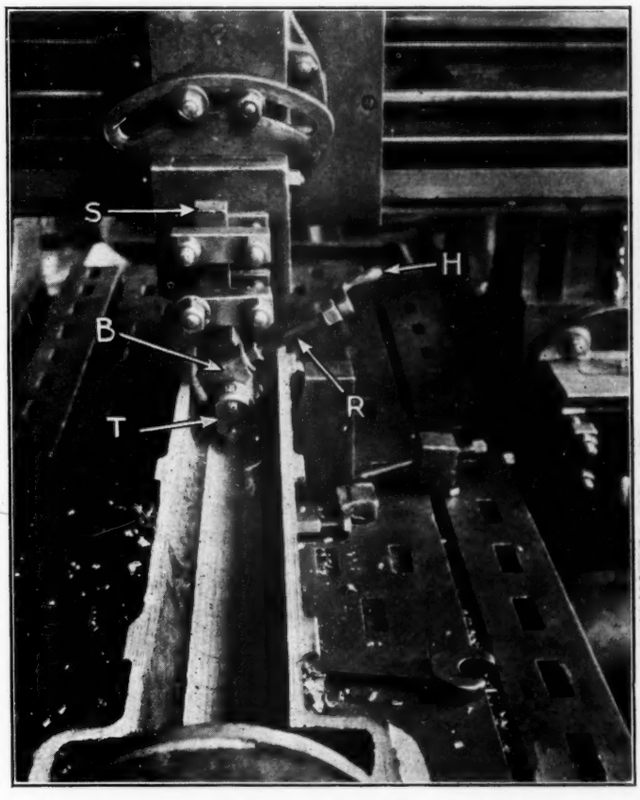
Now the oxyacetylene welder may wonder how this applies to his work. Suppose he was called on to weld the cast iron bed of a common engine lathe in a machine shop or some manufacturing establishment. If he did not know, he might consider the job as an ordinary iron casting and spoil it for, while such lathe beds are mostly of soft gray cast iron, the top part, called the shears, is of chilled iron to resist the wear of the machine parts which are moved over its surface. The same thing would apply to a cast iron car wheel, as its face is chilled, and there are many other iron castings which have certain parts chilled. It is always safe for a welder to assume that an iron casting having parts of its surfaces subjected to severe rubbing, called abrasive wear, will have such surfaces chilled..

It will now probably occur to the welder to ask if the preheating to a dark red of a chilled iron casting for welding would not reduce the chill and soften the iron, to which the answer is no, as the reason the metal is hard is because its carbon is chiefly in the combined state, and the only way to retransform it is to melt the iron and allow it to become solid very slowly which would allow most of the hard combined carbon to change to soft graphitic carbon and thus avoid the chill.

The welder should remember this when he attempts to weld a combined soft and chilled iron casting. If he heats the chilled iron to the molten condition and covers it as is the custom for ordinary castings, the part melted by the torch, and the weld, will be as soft as the rest of the casting. The correct way is to leave the melted chilled-iron part of the weld uncovered so that it will cool down quickly in the air, while the soft-iron part of the casting is covered and cooled slowly.

Radius-Planing Tool

An efficient radius-planing tool for machining extended piston rod guides and other similar work is illustrated herewith. The principle of operation of this tool will be readily apparent from the illustration in which the main body of the tool *B* is held in the planer tool post by clamps on the tool shank *S*. The tool head *T* is so arranged as to revolve,



Planing the Radius of An Extended Piston Rod Guide

the cutting tool being held in this head and adjusted to such a length as will give the required radius. The revolution of tool head *T* is obtained by means of handle *H* which turns rod *R* and a worm and worm wheel within the body of the tool. The feed of the cutting tool is obviously obtained by turning handle *H* a fraction of a revolution for each stroke of the planer. This device has been in service for a long time with satisfactory results. On the particular job illustrated it planed the extended piston rod guide in 55 min., 30 min. being required for the roughing cut and approximately 25 min. for the finishing cut.

Quality of Steel Determined by Fracture Test*

By W. J. Priestley

THE bulk of steel entering into finished machine parts in this country is forged, heat treated and machined in other plants than the plant in which it is melted and cast. Large quantities of high grade alloy steel, high carbon steel and tool steel are handled in this manner. The consumers, of whom railroads are one of the largest, purchase steel on its chemical analysis and surface inspection, no reference being made to the record of manufacture other than that the steel shall be made by the acid open-hearth, basic open-hearth, electric or crucible process. In some cases, the method of melting is not specified.

Frequently it happens that steel purchased in this manner is rejected after heat treatment or after machining due to defects which were not apparent in the purchased bloom, billet, or bar stock. Due to the fact that a customer may purchase only a small portion of the original heat of steel, it would be impracticable to demand with the purchased order of steel, its melting record. Furthermore, if this record were furnished, the consumer might not be able to interpret the same

Fig. 1—Test Discs Broken with Great Difficulty After a Single Quench and Draw

intelligently and know whether or not he was getting a satisfactory heat of steel.

In cases where complete detailed record of manufacture of steel forgings have been available, it has been found that a simple fracture test taken from the end of a forging, billet, or rolled bar stock, furnishes more conclusive data than many other tests which are more elaborate and more expensive. This test has been used for some time past for determining pipe in rolled stock. In this instance, the plane of the fracture is at right angles to the direction of rolling. Purchasers of high grade alloy steel and tool steel will find a fracture test equally serviceable and practicable for a determination of slag, inclusions, flake, blow holes, pipe, and excessive segregation, if taken so that the plane of the fracture is parallel to the direction of forging or rolling.

The test consists of sawing a disk about 1¼ in. thick from one end of the forging or bloom. If this small disk is quenched slightly above its critical temperature, drawn between 900 and 1,100 deg. F., and then broken in two, it will give a fracture parallel to the direction of forging or rolling which will disclose the texture of the metal. Flake, slag, blow holes, pipe and excessive segregation may be detected easily by means of this fracture test.

This test should supplement the usual test for chemical analysis and surface inspection. It affords a means of rejecting, before forging, heat treating and machining, any steel which contains any of the foregoing defects. In many cases

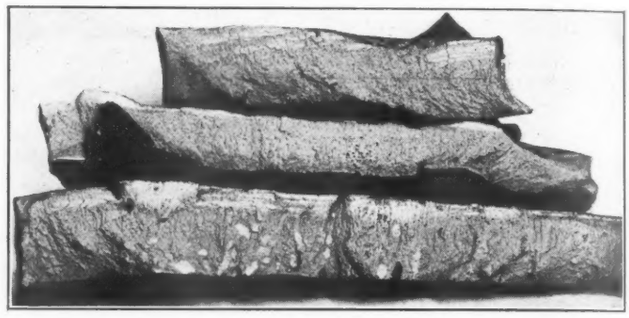


Fig. 2—Test Discs Taken from Blooms

steel with inherent defects is taken up for manufacture and when finally rejected, is blamed upon improper heat treatment on account of not having knowledge of these inherent defects.

Figs. 1 and 2 show disks taken from forgings as large as 10, 13 and 18 in. in diameter. It will be seen from Fig. 1 that the disks were broken with great difficulty after a single quench and draw. The way in which these disks bent without breaking gave almost positive proof that subsequent tensile tests from these forgings would be satisfactory. Four bars taken at right angles to the direction of forging of these blooms showed the following physical results:

Tensile strength, lb. per sq. in.	Elastic limit, lb. per sq. in.	Elongation, per cent	Reduction in area, per cent
95,400	61,000	25.2	53.2
97,500	68,300	26.	58.1
100,000	62,500	23.6	50.8
100,100	68,400	23.6	50.5

Attention is invited to the fact that these bars were taken at right angles to the original axis of the ingot and across the grain with respect to the way the metal was forged. This steel was 0.38 per cent carbon, and contained about 2.75 per cent nickel.

Fig. 2 shows three similar disks taken from other blooms. The top disk discloses minute inclosures of slag in the fracture. These may be seen by closely examining the illustration. They are about as wide as a needle and vary from ¼ to ½ in. in length. Physical test bars taken from this forging at right angles to the axis showed the following physical tests:

Tensile strength, lb. per sq. in.	94,000
Elastic limit, lb. per sq. in.	70,000
Elongation, per cent	12.2
Reduction in area, per cent	30

The middle disk, Fig. 2, shows a fracture of steel which is almost entirely free from slag or other impurities. Tensile bars taken from this disk showed the following:

Tensile strength, lb. per sq. in.	97,000
Elastic limit, lb. per sq. in.	70,000
Elongation in area, per cent	11.4
Reduction in area, per cent	24.9

*A paper presented before the convention of the American Society for Steel Treating at Indianapolis, Ind. The author is superintendent of the hot metal division, United States Naval Ordnance Plant, Charleston, W. Va.

The bottom disk, Fig. 2, contains bright silky spots, generally termed "snow flakes." These are very easily distinguished in the photograph. A tensile bar taken at right angle to the axis of this forging showed the following:

Tensile strength, lb. per sq. in.	94,900
Elastic limit, lb. per sq. in.	67,500
Elongation in area, per cent.	11.4
Reduction in area, per cent.	24.9

This information is furnished with the idea that it may be of some benefit to heat treaters who do not melt their own stock but purchase it in the form of blooms or billets. This is an inexpensive test and could be taken at the rolling mills or forge plants before shipment to the ultimate consumer. The saving effected by rejecting unsatisfactory steel before machining and heat treating would more than offset the slight cost of taking fracture tests of forgings, blooms or bar stock.

Head and Eye Protection*

The first steps in the direction of head and eye protection for shopmen were taken in 1912. Eye injuries were very numerous and as they were generally serious and involved long periods of disability, we adopted the use of goggles as a preventative measure. At first it was thought that only a few pairs would be needed but as the demand for them increased we extended that policy so that today goggles are furnished to each individual whose duties require this kind of protection.

In order to prevent fogging of the lenses due to moisture in the atmosphere, anti-sweat pencils are furnished which consist of a glycerine soap preparation to be rubbed over the entire surfaces of the lenses and wiped off dry. Where men are engaged in hot work, a special type of goggle, known as boilermakers' goggles, having extended frames providing additional ventilation and with all portions which come in contact with the face insulated with padding, have been found superior to the ordinary machinists' type goggles as they do not fog quickly.

Where there is considerable dust, as in the operation of blowing out boiler tubes, etc., rubber-mounted goggles are furnished which have no ventilation provided, and, of course, can only be used for short periods at a time without cleaning. Where sand blast operations are carried on, a helmet covering the head and supplied with fresh air from a forced ventilating system, is employed.

Head Protection

For the protection of the heads of men engaged in electric welding work it is necessary to provide a face mask. A protection glass, which excludes ultra-violet and infra-red rays from the iron arc, is mounted in the front of wooden or fibre shields held before the face by hand or by head attachments, the important features being the non-conductivity of electric current of the material used in the mask, ventilation, and the easy removal of the protection from in front of the face when the arc is not being used. One of the best masks for this purpose on the market, having a drop frame for holding the protective glass, was devised by one of our employees at the Columbus shops.

For oxyacetylene welding, eye-cup type goggles are used, the cups being made from material which is a non-conductor of heat or electricity. In order to determine whether the degree of protection afforded to men engaged in the oxyacetylene and electric welding processes was sufficient, quarterly examinations for acuity of vision were made by the relief department physicians on the eastern lines and the reports were favorable in respect to the results being obtained.

*Report issued by the Insurance Department of the Pennsylvania System.

At oil mixing plants where hard grease is manufactured a few employees handle caustic soda in large quantities and for their protection rubber hoods, fitted with face masks having respirators and clear glass lenses, are provided. Special instructions are issued to the men in charge of these plants relative to prompt action in case of caustic soda burns. A drop test machine has been built and installed in the test department at Altoona where goggles are tested for strength of lenses. A list of approved goggles has been compiled and placed in the hands of the purchasing agent.

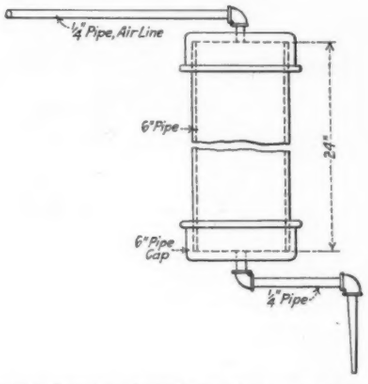
Abrasive machines are equipped with glass eye shields attached directly to the frame and at some shops exhaust systems are in use which carry away the dust. Chipping screens and rivet catchers are other forms of secondary protection which are quite generally in use for the prevention of eye injuries.

Screens are provided to be placed around electric welders for preventing the light from their operations reaching the eyes of men working near them. Separate rooms or screened areas are set aside for working on parts which have been removed from equipment. Propaganda against the use of match sticks, dirty handkerchiefs or other unsterilized implements for the removal of foreign bodies from the eyes should be continued.

Air Motor Grease Gun

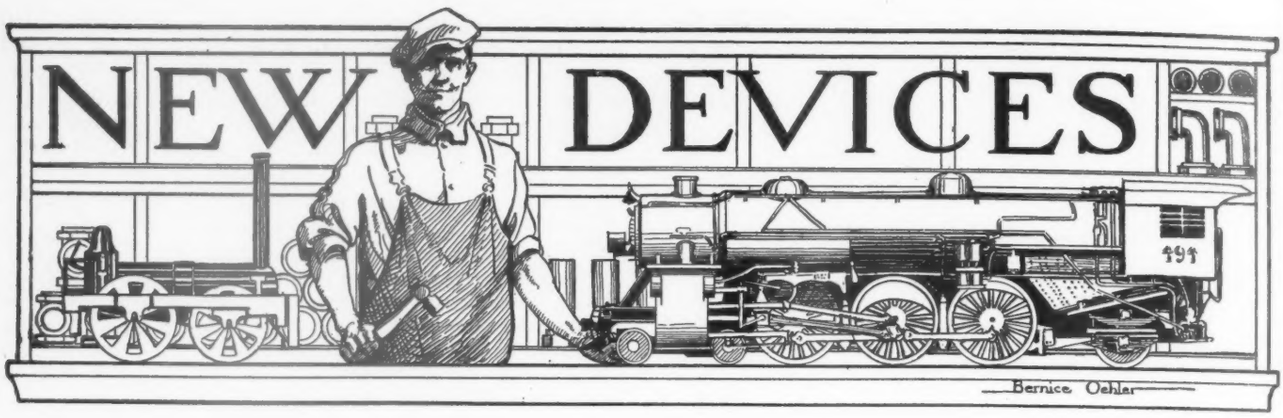
By B. C. Bertram
General Locomotive Inspector, Erie, Youngstown, Ohio

It has frequently been noticed that the grease for air motors, when allowed to remain around in open containers in tool rooms, collects more or less of the dust and grit flying about the shop. The illustration shows a device by which this grease may be confined in an enclosed grease gun to be injected into pneumatic motors by air pressure, as desired. The device is extremely simple, consisting of a piece of 6-in. pipe, 24 in. long, provided with a cap on either end. By opening a valve a ¼-in. pipe to the upper end admits air under pressure which forces the grease through the lower ¼-in. pipe and nozzle. A flexible rubber hose connection can be arranged from any of the shop lines, enabling this device to be used at any part of the bench where air motor repairs are being carried on.



Pneumatic Gun for Supplying Grease to Air Motors

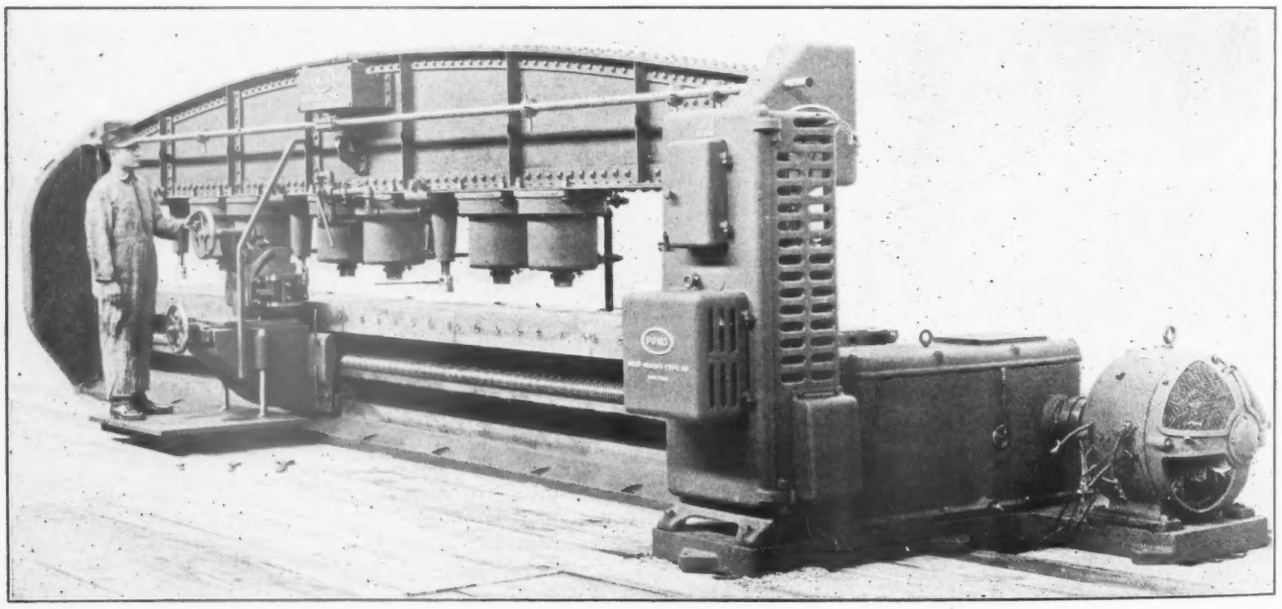
A particular advantage of this method of applying grease to air motors is that the plates on the side of the motor are not removed, as is customary when packing by hand. In using this pneumatic device, it is simply necessary to unscrew the dead handle of the motor and insert the nozzle, admitting air until the required amount of grease has been forced into the motor. The nozzle of this grease gun is made from a piece of ¼-in. pipe, drawn down.



Recent Improvements in Plate Planer

IN the new plate planers made by the Niles-Bement-Pond Company, New York, it will be noted that the design of the bed and carriage is such as to prevent chips from getting on the bearing surface of the carriage and screw. This adds materially to the life of these parts. The tool carriage is attached to the front vertical side of the bed, and is guided by square shears. It is secured at the top and bottom by removable bearing supports which will permit the carriage to be taken from the bed at any part of its length. The carriage is reversed automatically at any desired position by contact with stops adjustable on the shifter rod. The operator can start, stop, or reverse the carriage by manipulating this shifter rod by hand. This can be done with very little effort on the part of the operator.

The main driving gears are enclosed in a box, and run partly submerged in oil. The motor is controlled by a master switch attached to the shifter rod, and an enclosed panel with forward, reverse, accelerating, and dynamic brake contactor. A push button is mounted on the right hand housing, so that the machine may be started and stopped without manipulating the shifter rod. The cutting speeds range from 20 to 40 ft. per min.



Niles-Bement-Pond Plate Planer of Improved Design; Arrangement for Keeping Chips Out of Carriage Ways and Screw a Valuable Feature

The bearing surfaces are provided with taper gibs for taking up wear.

Two relieving tool holder slides are mounted on a standard, and have simultaneous vertical adjustment by means of a screw and hand wheel, and horizontal adjustment to the standard through a screw and hand wheel. Both tool slides are arranged to swivel for planing bevels.

The drive screw is supported in a trough with an oil channel of sufficient depth to cover the full depth of the thread with oil. Roller bearings are provided to take the end thrust of the screw. The pneumatic jacks are of the two-way type, i.e., air is admitted in the top for clamping the plate. For unclamping, the air is admitted at the bottom.

The housings for the clamp beam overhang the bed so that plates of any length can be planed by shifting them along the bed and taking a series of cuts. These planers are equipped entirely with pneumatic jacks, or with hand-operated screw jacks, or with both types as illustrated in the photograph.

This type of plate planer is built to plane plates from 1 in. to 2 in. thick in five standard sizes, the maximum length planed at one setting ranging from 12 to 25 ft.

Coping Machines for Steel Car Shops

MANY, and perhaps it is safe to say most, railroads are poorly equipped with shops and particularly machinery for making repairs to steel cars. This lack of facilities will be keenly felt especially in the next few months when an abnormally heavy coal traffic and crop movement will create a big demand for freight cars. Bad-

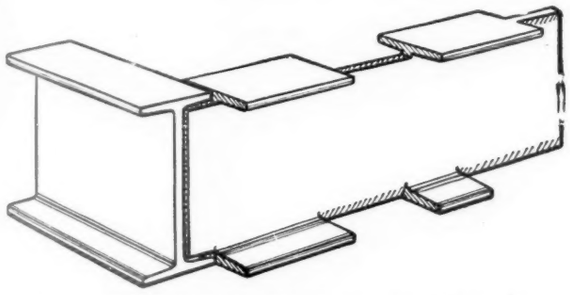


Fig. 1—Shaded Sections Removed by Coping Machine

order cars must be repaired and returned to service as promptly as possible and one of the best ways to facilitate this work is by installing a sufficient amount of modern labor-saving machinery.

In steel car construction and repair work, coping machines of the type illustrated perform a valuable function. They

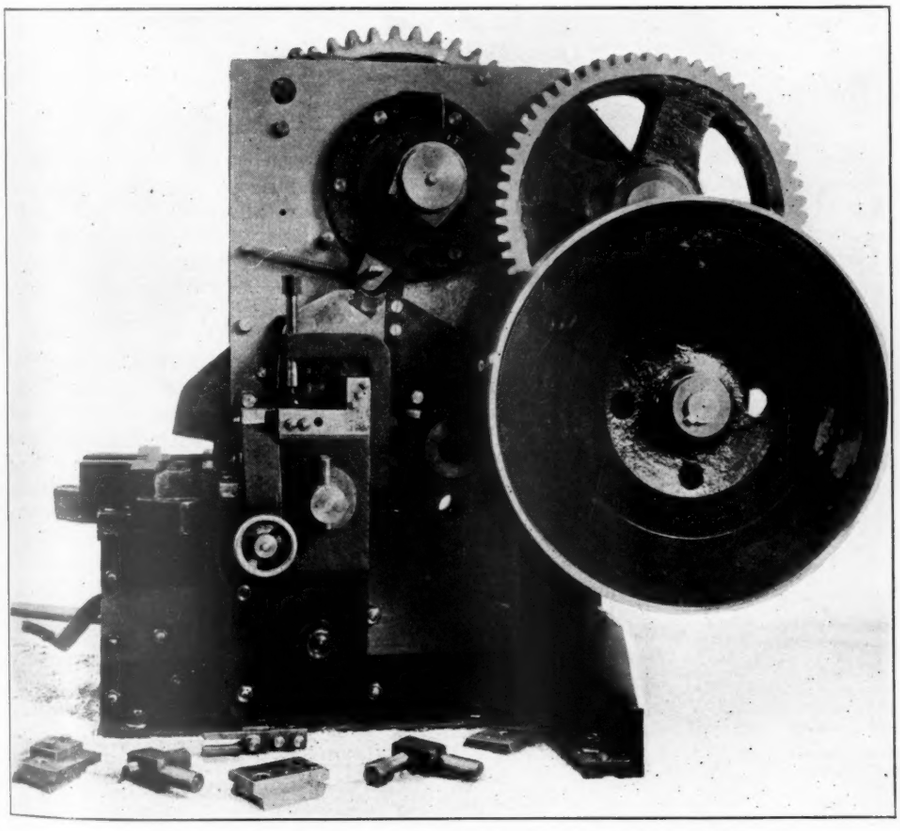


Fig. 2—Pels Coping Machine for Blocking Out Steel Beams and Channels

are used in miscellaneous blocking-out work and, as shown in Fig. 1, for cutting beams and channels in such a way that they will fit together accurately in a car without subsequent machining, sawing, or filing. Certain operations on channels are troublesome since it is necessary in an end sill, for example, to cut away the flange and a considerable portion of the web of the channel in the center of the section where it fits over the draft gear. The coping machine will perform this work on an end sill member in less than one minute, whereas, if the work is done with a cold saw, it will take from 20 to 30 min. to accomplish the same result.

A single-end coping machine, designed for the above purposes and of the same general type as coping machines successfully used by prominent car companies for many years, is announced by Henry Pels & Co., New York. It is illustrated in Fig. 2 with certain parts of the tooling equipment in the foreground. This machine is made in four sizes and in double end as well as single end design, being intended as explained above for handling structural framing and coping operations which in many shops are slow and expensive to perform. Cutting away the flanges and beveling the webs of beams or channels (Fig. 1), for example, is a lengthy operation unless use is made of the coping machine which takes off each flange with a single stroke of the machine, the web being rounded with the knives shown on the side of the machine.

Rugged Frame Construction a Special Feature

As with the Pels triple combination punching and shearing machine, described on page 537 of the September *Railway Mechanical Engineer,* the coping machine is made of heavy steel plates of definitely calculated tensile strength and elastic limit. In the larger sizes the plates are hydraulic forgings. The frames are designed with an unusually high factor of safety, the intention being to provide frames which no duty, planned or accidental, can fracture. The gears are made of steel with accurately cut teeth, the pinions being forgings. All shafts of large diameter are also forgings. Bushings are made of phosphor bronze and the main bearings are provided with ring oilers. The machine is designed to perform continuously and with ease at the highest capacities named and, on account of their construction, the frames are guaranteed without reservation to be unbreakable.

One of the features of this coping machine is its ability to remove the entire flange of a channel or beam if this is desired. The front knives are so constructed that the entire fillet is removed with the flange. This is a feature said to be characteristic of the Pels machine alone. The coping machine, illustrated, is known as the type Reat No. 45 B and will make standard coping cuts on beams and channels up to 20 in. 75 lb. Flats, angles and plates up to ¾ in. thick can also be accommodated. An eight-horsepower driving motor is used, the speed of the fly wheel being 260 r.p.m. The diameter of the driving pulley is 25½ in., the driving belt being 4 in. wide. The machine will make 18 strokes per minute. Its overall dimensions are 68 in. long, 50 in. wide, 76 in. high. The net weight is 9.700 lb. When desired, the machine can be easily mounted on a turntable but this is seldom necessary for railroad shops.

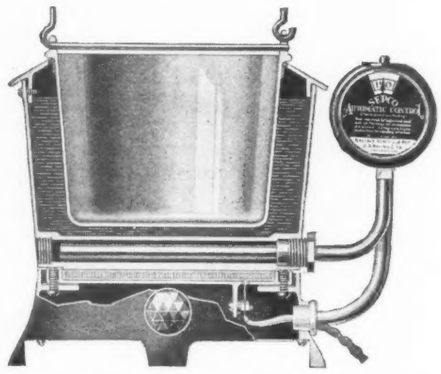
Glue Pot with Automatic Heat Control

GLUE attains its greatest flexibility and viscosity at about 140 to 150 deg. F. At a temperature of 176 deg. F. glue loses its tensile strength. Similarly, if it is cooled to 104 deg. or less, there would be a decided fluctuation in the strength or holding quality. Obviously, some kind of heat control in glue pots is desirable and this is obtained in the one illustrated, made by J. D. Wallace & Co., Chicago.

This glue pot is provided with a tube immediately above the electric heating element containing a sensitive volatile substance which contracts and expands with the slightest change in temperature and provides a dependable action of ample power to actuate the control switch. When the water around the glue pot reaches the proper temperature (150 deg.), the control turns off the current. When the temperature falls a few degrees, the heat is turned on again. Since this action is automatic, workmen need not watch thermometers and an increase in production is the direct result. The temperature gage dial always shows the heat attained and, together with the jewel set in the base casting, acts as a visible check on the heat maintained.

The glue pot operates from any electric lighting circuit and is put in operation by merely turning the switch. This glue pot functions either as a water bath, hot air, or dry heat pot and whichever way it is used, does not overheat, even if the current be left on indefinitely.

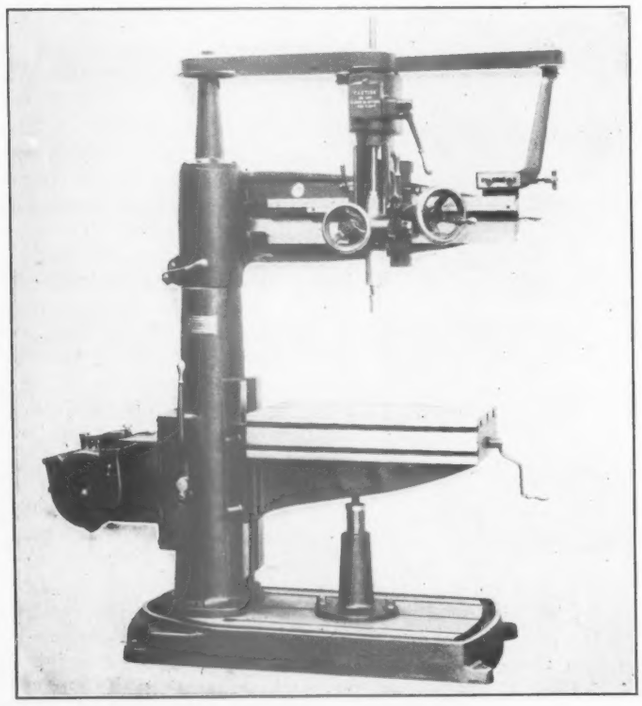
The durable cast aluminum glue container is supported by special lugs which prevent floating when the pot is only partly filled with glue. The escape of moisture is minimized by this method. The base cover forms a dead air heat insulating chamber between the heating units and the bench, and the air gap which surrounds the heating unit provides further insulation between the heat units and the base casting. The method of insulating electrical parts provides ample fire protection. This glue pot is adapted for heating any substance which requires a definite working temperature, such as glue, wax, pitch, tar, sealing compounds, or resin.



Wallace Glue Pot Arranged for Automatic Control of Temperature at Any Desired Point

Ball Bearing Sensitive Radial Drill

THE object of a new high speed radial drill, developed by the Fosdick Machine Tool Company, Cincinnati, Ohio, is to drill and tap work of too large an area for the high speed sensitive upright drill. The rapidity of positioning the drill, together with ease and convenience of operation minimizes the time "between holes," while high speeds and excess power reduces the actual drilling time.



Fosdick Radial for High Speed Drilling of Large Work

The table is readily removed, allowing 49½ in. between the spindle and base, which has a working surface of 28 in. by 36 in. and is planed and provided with T-slots. The vertical movement of the table is 16 in. through a ball-bearing telescopic screw. The working surface is 20 in. by 33 in. with 21 in. maximum to the spindle.

The arm, sensitive in its movement, may be swung completely around the column, and is supported on both annular and thrust ball bearings on the column, which extends through to the top. The spindle, as all other revolving members, is equipped with ball bearing journals. It has a No. 2 Morse taper, and a vertical traverse of 8 in. The horizontal movement of 28½ in. along the arm is through rack and spiral gear with the handwheel to the right. This position of the hand wheel enables the operator to swing the arm and move the head simultaneously with the right hand, while the left hand is free to raise and lower the spindle, and clamp the arm.

The sensitive feed and quick return are operated by the lever at the right, or the handwheel at the left. Friction back gears, a new feature for a machine of this type, permit instantaneous shifting from high drilling speeds to slow speeds for tapping or drilling large holes, the ratio being 4½ to 1. The tapping attachment frictions, like those of the back gears, are easily adjustable with an ordinary screw driver. The drive is regularly through tight and loose pulleys on the machine which gives both a high and low speed forward and reverse. The pulley guard and belt shifter are adjustable to meet the belt from any angle.

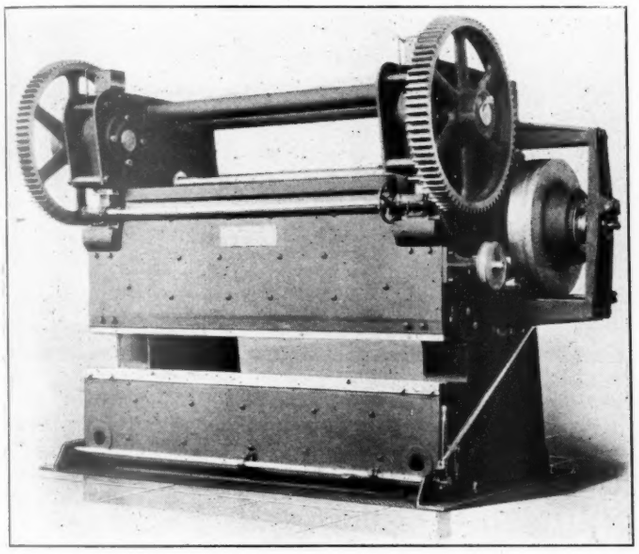
Another important improvement is the full tractive contact of the belt, which maintains a uniform tension at every position of the head. A reservoir for coolant is cast in the base, and a pump with nozzle to the drill point can be supplied.

Separate box or universal tables can be furnished as extras in place of the regular elevating rectangular table.

Motor driven machines require a 1 hp. motor, either constant or variable speed, as desired. The machines are built with either 3 or 3½ ft. arms; the dimensions mentioned above being for the 3 ft. size, which weighs 2,650 lb.

Cincinnati All-Steel Power Press Brake

AN interesting development in the manufacture of heavy brakes has just been disclosed by the Cincinnati Shaper Company, Cincinnati, O., with the introduction of the Cincinnati all-steel press brake. This line of brakes has been designed with an open side in order to facilitate the handling of material. As most bends are made near the edge of the plate, the full length of the die-holding surface can be utilized. Thus, for most classes of work, a machine can be rated with respect to the length of the die-holding surface instead of the distance between housings, which means the use of a narrower, more rigid machine, and a saving in cost and floor space.



Cincinnati Power Press Brake With Multiple Disc Clutch

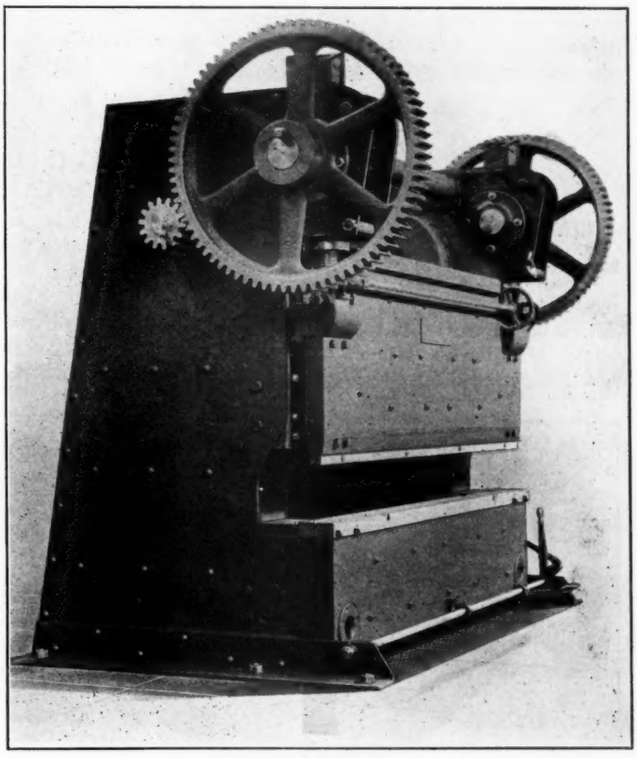
In addition to freedom from all interference at the front of the machine, there is an absolutely clear space between the housings at the rear for convenience in stacking finished work. Where more than one operation is required, the work can be passed back and forth through the machine, avoiding the inconvenience of turning end for end.

The bed and ram are constructed entirely of heavy steel plates and billets, which, together with cross ribs, are welded to each other, thus making what is virtually a heavy solid steel beam of box section with the metal placed to the best advantage. The housings are framed of steel plate, having cast steel members interlocked and welded to the plates. These members are provided with heavy trunnions for supporting the bed. The machine is designed for maximum simplicity, and all elements are combined to secure the essentials of power, rigidity, speed and convenience of operation. Automatic sight feed lubrication is provided on all power driven bearings. The fly wheel, clutch, worm and worm wheel ram adjusting device, and the power drive for this, all run in a bath of oil.

All main drive bearings are of special bronze. A splined trip shaft runs the full length of the machine, on which is mounted an adjustable foot treadle which enables the operator to engage the clutch from the most convenient position. The ram is gibbed endways as well as sideways. This is essential when using the machine as a gang punch. When the machine is to be motor driven, the motor is mounted on a bracket attached to the housing. The drive is through a belt, held in tension by a weighted idler pulley applied on the slack side.

To meet the demand for increased production these machines have been designed to operate at a greater number of strokes per minute than has been customary in brakes heretofore. The fly wheel is mounted on high duty ball bearings having hardened steel inner and outer races. All gears are accurately cut and the pinions are of steel. The clutch is of the multiple disc type, especially designed and developed for this particular tool and operated in oil. It is accessible and simple to adjust. The clutch is designed to be highly efficient, very low unit pressures being used in its operation and shows remarkable results under tests.

For instance, the clutch, while adjusted to pick up the full load under a standing start with the ram down against the work, is said to have been repeatedly thrown into engagement when the dies were together, thereby stopping the fly wheel in a short period of time. A test of this sort is a demonstration of the action which may be expected when the dies are brought together accidentally, generally the cause of breakage in machines of this type.



View Showing Rugged Construction of New Press Brake

The advantages of this steel brake include: maximum strength and power with minimum weight; greatly reduced deflection over that generally found on machines of corresponding capacities; the open throat type of machine permitting continuous work, or the forming of sheets of greater

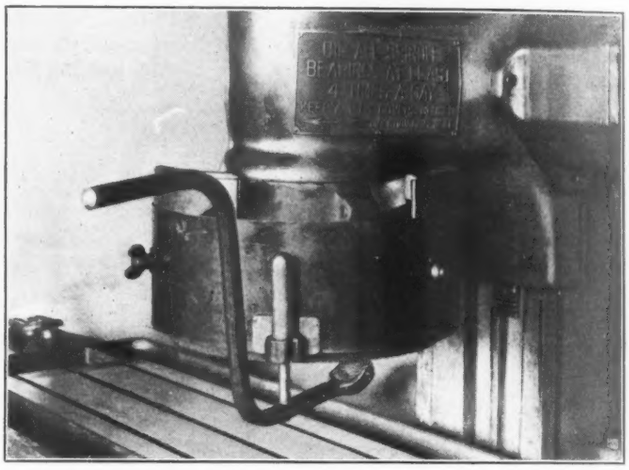
width than the clear distance between the housings; reduced amount of head room required; quick action and increased operating speed; ease of installation and erection; and a high factor of safety against accidental injury to the machine.

These brakes are built in capacities ranging from 80 to 600 tons for working material from 10 gage to ¾ in. in thickness. The widths between housings are 6 ft. 6 in. to 14 ft. 6 in.; the weights 18,000 lb. to 120,000 lb.

Safety Wheel Dresser for Surface Grinders

MANY operators claim that satisfactory results cannot be obtained except by the hand method of wheel dressing, but this is more or less unsafe and is never advocated. The new style dresser brought out by the Pratt & Whitney Company, New York, for use on its vertical surface grinders is designed to give all the advantages of hand dressing without danger of injury to the operator. It consists of a bracket bolted or riveted to the wheel guard which supports the stem of the dresser. The dressing wheels are held in one end of the device, the bar being bent to fit under the wheel. The other end forms a handle so that the attachment can be easily moved into position. No change in the work and wheel relation is necessary and the device is said to be quick acting and thoroughly efficient. It may be readily applied to grinders now in use and is furnished as regular equipment on new machines.

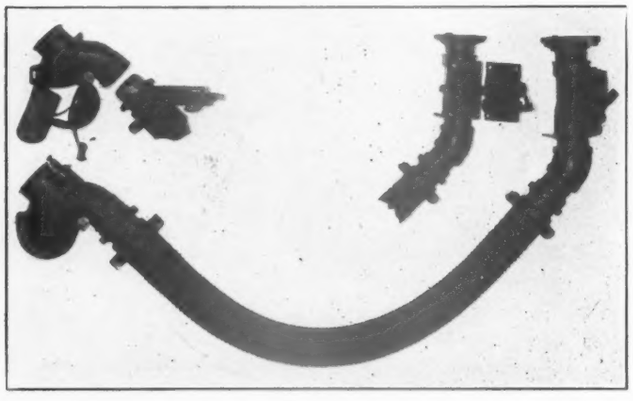
Perhaps the most important feature of grinding machine operation is keeping the grinding wheels in proper condition. For smooth and accurate work the wheels must be true. Frequently, especially when grinding relatively soft metals, the grinding wheel surface becomes clogged and must be dressed. For this purpose the safety wheel dresser illustrated is effective and always ready. It can be used frequently on account of the ease and safety of operation, thus keeping abrasive wheels in first class condition.



Pratt & Whitney Safety Grinding Wheel Dresser

Safety Locomotive Feed Water Attachment

SIMPLICITY of operation, the absence of threads, and all parts secured in position are three features of a new safety feed water connection between engine and tender, recently patented by W. F. Potts, Kansas City, Mo. This device has been tested for two years on a prominent railroad in the Middlewest with entirely satisfactory results. In the new design hose nuts and gaskets are eliminated by arranging a body casting having a taper socket which engages the hose sleeve; and a yoke that connects to the hose sleeve at lugs, swinging over a projection on the body. The yoke is provided with a taper key notched to engage a spring pawl. When the key is driven in place it draws the hose sleeve into the socket fit, making practically a solid connection with the spring pawl and automatically locking the key in the closed position. The key is provided with a cotter pin as security and has a fool proof stop preventing its abuse. A dowel through the key prevents it from being dropped out of the keyway.



Engine Connection (left); Tank Valve and Connection (right)

For examination and cleaning of the strainer, a screwless opening is provided in the body casting. The strainer is set on an angle allowing foreign matter to wash from the surface. The strainer opening also is provided with a depression cover which forms a trap, retaining the dirt that is drawn from the tank and washed from the strainer face. This also prevents the substance from returning to the low portion of the hose. The strainer cavity cover is held in position by a yoke, drawn up with a key and secured with a cotter pin. The strainer and yoke key are chained to their position, securing them from being lost or dropped. This arrangement forces the operator to replace the strainer before the dirt trap can be closed. The possibility of hose slipping off a hose sleeve is prevented by introducing a special clamp, made in halves and bridled to lugs on the hose sleeves. A durable clamp, easy to remove, is thus secured, clamping advantages being obtained by the use of two bolts with extension heads. The rear hose nut and gaskets are eliminated by screwing the hose sleeve on the pipe connection.

The tank valve body complete is placed on the bottom and outside of the tank. The valve is of brass and is held on a brass lever by cast yokes on the top of the valve, eliminating nuts and pins. The construction of the valve body is such that it is impossible to disconnect the valve while the valve hood cover is in position on the body casting. The valve in open position is back in the hood and engages a brass spring, which holds the valve and prevents vibration. The lever shaft is of brass arranged to be disassembled before it falls apart from the valve lever or handle.

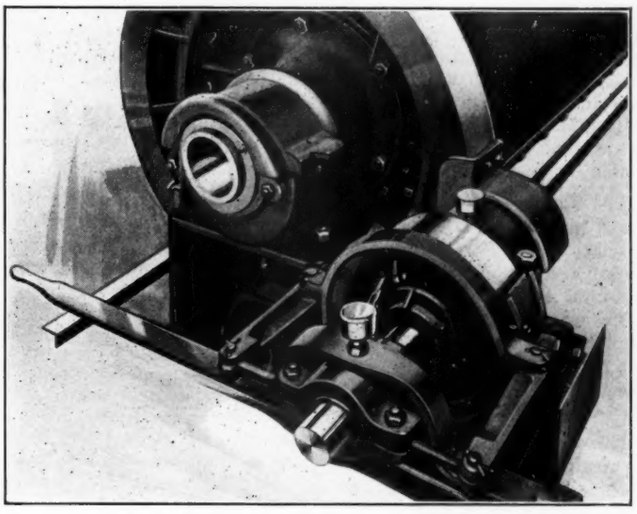
The tank valve like the other parts was built to overcome common weaknesses and eliminate the necessity of going

inside of the tank to make inspection and repair. The tank valve can be applied without getting on or going inside of the tank. It prevents frozen decks or steps due to leaking water bottom stuffing boxes and tank valve stems. It removes an obstruction, adds a valuable space on tank legs for engine equipment and gives an opportunity to locate the tank valve where it will not be damaged in derailment. It provides a standard valve for all engine tanks. The apparatus tested was put in service October 15, 1920, and is reported to have been in continuous operation since without developing a defect or costing anything for repairs. It is claimed that the tank valve can be closed, using so simple a tool as a rail spike, the yoke key tapped out, the strainer removed and replaced and the tank valve reopened ready to operate the injector in 17 seconds. This ease and speed of manipulation is a valuable feature for preventing locomotive delays.

Clutch and Brake for Tumbling Mills

THE desire to insure safety has resulted in many improvements in foundry and shop equipment as, for example, the combination clutch and brake mechanism for tumbling mills illustrated. This is a simple device, controlled by a hand lever and said to be fool proof. Shifting the lever towards the mill engages the clutch and starts the mill. To stop the mill, the lever is moved in the reverse direction, passing through neutral to the braking position.

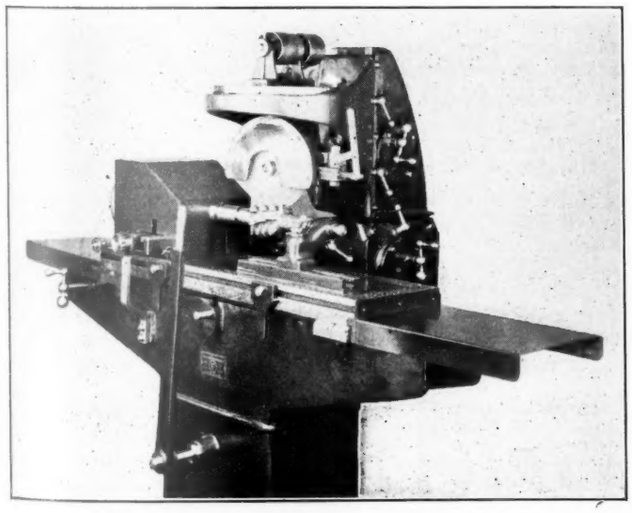
The advantages of such a mechanism are easily seen. A loaded mill can be brought to rest at exactly the right point for unloading and without loss of time. Holding the mill in place by a wood prop or a bolt thrust into the gearing, as is commonly done, is always dangerous. With the combination clutch and brake it is impossible for the barrel to turn after the brake is set, even though the barrel is unequally loaded. The new Whiting clutch and brake could doubtless be applied with advantage to tumbling mills used for various purposes in railroad shops and would be especially valuable if used in connection with the large number of flue rattling devices now in service. This mechanism has been devised and placed on the market by the Whiting Corporation, Harvey, Ill.



Whiting Safety Clutch and Brake

Machine for Sharpening Hobs and Form Cutters

TO meet the demand for an efficient hob grinder for use in shops where the number of hobs and form cutters to be ground does not warrant the purchase of a full automatic grinder, the Harris Engineering Company, Bridgeport, Conn., has developed the semi-automatic machine illustrated. The hob or cutter to be sharpened is carried on an arbor with a taper shank fitting into the work-carrying spindle; the outboard end of the work is supported by a center in an adjustable tailstock. On account of the table being mounted on ball-bearings, the action is so sensitive that the operator can tell from the feel on the handle of the long lever whether the grinding is too heavy or too fast.



Harris Semi-Automatic Hob and Form Cutter Sharpener

Hobs having helical flutes are rotated during the travel of the table by a sine bar, instantly adjustable to different angles, which actuates a cross-slide carrying a rack meshing into a gear on the work spindle. Two sets of notches are provided on the index plates, one for indexing and the other for escapement. They are designed to prevent wear on the notches used for indexing. The indexing mechanism is semi-automatic and can only operate at the end of the return stroke. At this point the operator with his left hand pulls the hand wheel as far forward as it will go and the hob is then indexed to the next flute.

The grinding wheel spindle is driven by an endless open belt of heavy leather without twists or idler pulleys and of sufficient thickness to transmit the necessary horsepower to the 8-in. special form wheel used. An important feature is the diamond truing device for dressing the wheel, built into the head and always in position or use without disturbing the work. Another advantage is the arangement to true the wheel to grind the faces of hob teeth radial, or with a top rake if desired.

These machines are furnished with countershaft drive or individual motor drive. The table travel is 15 in. with a maximum diameter and length of work of 8 in. and 10 in. respectively. Hobs with 4 to 26 flutes may be accommodated. The maximum helix of the flute is 47 deg. and 8 in. diameter. The wheel is designed to be run at a speed of 2,700 r. p. m.

GENERAL NEWS

The Erie has cancelled its contract with the Hornell Machinery Company which has been operating its shops at Hornell, N. Y., and at one or two other terminals.

The shopmen of the Central of Georgia have organized two unions, one the Central of Georgia carmen's organization and the other the Central of Georgia metal trades' organization. C. O. Voss, of Savannah, is chairman of the carmen, and W. J. Bice, also of Savannah, a boilermaker, is chairman of the metal trades. It is said that the new unions have already made contracts with the railroad company, which conform to the rulings of the United States Labor Board.

The Engineering Institute of Canada held a general professional meeting at Winnipeg, Man., on September 5-7, with headquarters at the Fort Garry Hotel. The program on Tuesday included descriptions of the Winnipeg hydro-electric plant and the Manitoba Power Company's development at Great Falls. On the following day these plants were visited by special train. On Thursday papers were presented on the construction of the Moncton yard and engine facilities of the Canadian National by S. B. Wass and on automatic grain car unloaders for the Canadian National Railways at Port Arthur by Fred Newell.

The Paris-Orleans Railway (France) has placed an order for 80 electric locomotives with the Société Oerlikon and the Société de Construction des Batignolles, both of Paris; these locomotives are each for a one hour rating of 1,720 hp. The Société Oerlikon is to supply and erect the electrical equipment, while the Société de Construction des Batignolles deals with the mechanical part. Except in the case of the five first locomotives, which will be completed at the Swiss works of the Ateliers de Construction Oerlikon, and will serve as models, the whole electrical equipment will be built in France, to the Oerlikon design, at the works of the Société Oerlikon. The locomotives are specially intended for freight trains and are to be capable of hauling a load up to 1,200 tons; they are, also, to be suitable for passenger service, in which case a speed of about 68 miles per hour must be attainable.

Ball Bearings for Journal Boxes

The Swedish branch of the Skefko Ball Bearing Company, Limited, has secured an order from the Swedish States Railways for 1,360 journal boxes for passenger coaches.

British Concern Gets Order for 21 Locomotives

The British firm of Sir W. G. Armstrong, Whitworth & Company has, according to The Engineer (London), received from the Bengal North Western Railway an order for 21 locomotives.

English Coal Strike's Cost to Railway Employees

According to the financial report of the National Union of Railwaymen, the miners' strike of last year cost the railwaymen's organization nearly £750,000 ($3,645,000 at the normal rate of exchange) in unemployment payments.

New Union on M. & St. L.

The shop employees of the Minneapolis & St. Louis have organized a new union under the leadership of W. A. Liehl, who has been elected president. "We have formed this association at the suggestion of the wage board," Mr. Liehl said. "We have a set of officers who can be dealt with and, in a diplomatic way can settle disputes, thus avoiding friction and strikes. Our organization will extend to all the shops of the road. I believe that 75 per cent of the striking shopmen who are out did not go out of their own free will; and they fear the torrent of abuse they would get if they went back to work."

Two Swiss Railways Electrified Throughout

The St. Gotthard line in Switzerland is now completely electrified for both freight and passenger service. The line extends from Lucerne to Chiasso on the Italian border, a distance of about 180 miles. Grades of 2.5 per cent are common and there are many tunnels, the longest of which is 9¼ miles. Completion of the electric operation of the Rhaetian Railways in Switzerland was celebrated in May of this year.

Technical Details of Portuguese Railway Equipment

Consul General Hollis at Lisbon has prepared a report called "Equipment on Portuguese Railways," which can be obtained by any interested manufacturer by applying to the Bureau of Foreign & Domestic Commerce, Washington, D. C., and asking for exhibit No. 64991. This report shows the various standard types of locomotives and freight and passenger cars in use on Portuguese railways, giving complete technical details.

Northern Pacific Sued by Strikers

Former Northern Pacific shopmen at Pasco, Wash., 28 in number, have filed suits against that railroad for $1,000 each, as damages for alleged refusal of the company to employ them. After the strike was declared the railroad management decided to build a fence around the shops at Pasco, and a contract for building the fence was let to a construction concern. The 28 idle shopmen applied for work on this job, but were rejected.

Study of Alloy Steels

The results of studies in the experimental production of certain alloy steels are given in bulletin 199, by H. W. Gillett, chief alloy chemist, and E. L. Mack, assistant alloy chemist, which has just been published by the United States Bureau of Mines. It contains detailed information regarding tests made with uranium, silicon, manganese, molybdenum, chromium, nickel, copper-nickel, aluminum, zirconium, cerium and boron as alloying agents.

Handbook of United States Safety Appliances

In response to demand from the members, another edition of the small Safety Appliance Handbook, covering all classes of cars and locomotives, for use of inspectors and others, similar to that issued in 1915 by the Master Car Builders' Association, revised to date, has been issued by the Mechanical Division of the American Railway Association. These books will be supplied on requisition to members or others by the secretary.

Indian Railways to Buy Locomotives and Cars

The East Indian Railway, according to Modern Transport (London), will during the fiscal year 1923-24 add 37 locomotives to its supply of motive power and contemplates similar additions annually for the next few years. From 2,000 to 3,000 goods wagons will be acquired annually during the next five years, and 136 passenger cars will be purchased before March, 1923. The road is also doing a considerable amount of double tracking.

The Bengal-Napur Railway will spend 1,567,000 rupees for passenger cars and 11,630,000 rupees for goods wagons (one rupee equals 32.4 cents at par).

New Cars in 1922

The railroads of the United States, in the seven months from January 1 to August 1, this year, had 25,763 more new freight cars, either ordered and under construction or installed in actual service, than during the entire year of 1921, according to a statement issued by the Association of Railway Executives; seven months this year, 95,199 cars; 12 months of 1921, a total of 69,436.

Of the total ordered or installed this year, 41,405 were coal cars and 39,612 were box cars. The railroads are also augmenting their supply of refrigerator cars. On August 1, 3,870 had actually been placed in service, while 6,428 more had been ordered.

Coroner's Jury Reports on P. R. R. Car Shop Fire

The fire at Pittsburgh, Pa., on September 3, in which seven employees of the Pennsylvania Railroad were burned to death in their lodging room, has been investigated by a coroner's jury and a verdict was rendered on September 13 to the effect that the origin of the fire could not be discovered. The verdict censures the officers and employees of the railroad company for housing 25 men in a building containing a large quantity of inflammable material, including oil-soaked waste and petrolite; for making changes to convert this shop or storehouse into lodgings without securing a permit from the city, and for maintaining an exit stairway too narrow. The verdict also said that the railroad company had fire-fighting equipment in and near the building, but had no efficient organization for handling the apparatus.

French Railway Orders Control Equipment for 120 Electric Locomotives

An order covering the complete control equipment for 120 electric locomotives, now under construction, has been received by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., from the Paris-Orleans Railway of France, as part of an electrification contract amounting to approximately $8,000,000.

The Paris-Orleans Railway, which is one of the largest systems in France, operating over 5,000 route miles of track, is electrifying 125 miles of its main line between Paris and Vierzon. This is the first of an extensive program laid out by the Paris-Orleans for the electrification of its lines.

The complete order of control equipment will be manufactured in the United States and shipment of this order will commence in January, 1923, and extend to December, 1924.

Labor Board Again Rules Against Contracting

Several decisions directed against the practice of contracting on various railroads were handed down by the Labor Board on September 11 and subsequent days. These decisions, involving the Erie; the New York Central; the San Antonio, Uvalde & Gulf; the Great Northern; the Chicago and North Western; the Cincinnati, Indianapolis & Western; the Chicago, Milwaukee & St. Paul, and the Chicago Great Western, follow, practically word for word, the Board's ruling in the Indian Harbor Belt case, described in full in the *Railway Age* of May 13, page 1111.

In every case the practice complained of by the employees had been discontinued before or soon after the strike of shopmen began on July 1. At the Board's inquiry on June 31 into the strike situation all of the roads involved in these decisions, except the Erie, announced the discontinuance of the practice of contracting or made a promise to do so as soon as possible.

South African Railways Ask Bids on Power Plant Equipment

Tenders are invited for the supply and erection in South Africa in connection with the electrification of the South African Railways and for use in the Maritzburg-Glencoe power house, of the undermentioned plants: coal handling plant, ash handling plant and circulating water plant. Specifications, blue prints and forms of tender for each of the above sections may be obtained from the office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W. C. 2, England. The charge for each specification is £5:5:0 for the first copy and £2:2:0 each for any further copies. Sums paid for any number of each specification up to three will be refunded on receipt of bona-fide tenders. Sealed tenders are to be addressed to the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, England, and to be delivered in duplicate not later than noon on Wednesday, October 18, 1922.

Suspension of Hydrostatic Tests of Tanks of Tank Cars and Safety Valve Tests

The Mechanical Division of the American Railway Association has announced that upon recommendation from the Committee on Tank Cars, that part of Sections 23 and 24 of the Standard Specifications for Tank Cars, Classes I, II, III and IV, covering the requirements of testing of tanks hydraulically and testing of safety valves, has been suspended as to tanks for which such tests shall become due prior to January 1, 1923, except when such cars are shopped for repairs.

The requirements of Section 23 of each of the specifications named, that new tanks shall be tested before being put into service, and that tanks damaged to the extent of requiring patching or renewal of one or more sheets, or extensive reriveting or recalking of seams, shall be retested before being returned to service, are not suspended.

The requirements of Section 24 of each of the specifications named, that safety valves on new cars shall be tested and adjusted before cars are placed in service, are not suspended.

Australian Road Uses Motor Cars

The Victorian Railways, Australia, have adopted the rail motor car to handle passenger traffic on short spur lines and over other sections where it is uneconomical to provide a service of steam trains, says the Times (London) Trade Supplement. Experiments in the past have been made with steam and gasoline cars, but for various reasons these have failed to give satisfaction. In the new system an ordinary motor-truck chassis is used as the power unit, the steering gear being removed and standard railway tires fitted to the wheels. The car, which has been designed to provide the maximum of floor space, has a seating capacity for 43 persons and all unnecessary tare weight has been eliminated. It is open at the sides, but is provided with blinds, which can be lowered for protection against inclement weather. The seats all face to the front and are of the usual tramcar type, and while they afford little lodgement for dust, provide ample comfort for short journeys. Hand luggage and parcels can be accommodated under the seats and the doors have been arranged near the front end so that the driver may be able conveniently to collect fares and issue tickets to passengers. A trailer built on similar lightweight lines has also been constructed and will be attached to the rail motor-car as traffic requirements warrant. Both the motor-car and the trailer are lighted by electricity. The maximum speed will be from 25 to 30 m. p. h., but the average speed will be considerably less, depending on the frequency of stops.

Continuous Brakes Advocated in England

The beneficial effect likely to be exercised upon safety in railway operation by the use of automatic brakes upon freight trains cannot be appreciated without taking into consideration other statistics than those furnished by an examination of the accidents officially inquired into, said Col. J. W. Pringle, chief inspecting officer of the Ministry of Transport (England), in addressing the British Institute of Transport. It has been mentioned that, in the year 1921, there were 8,876 cases of trains dividing. Of these, 6,354 were concerned with freight trains (not equipped with automatic brakes), and 2,522 with passenger trains. The accidents resulting from these cases of division were 50 and 5, respectively. The liability to accident from division appears, therefore, to be four times as great in the case of trains not equipped with automatic brakes. It is estimated that, in the 50 cases of accident due to break-in-twos of freight trains, more than half would have been prevented by use of an automatic brake. A number of crossing accidents also yearly result from difficulties experienced in controlling, or by misjudgment of breaking effect upon, trains not equipped with air or vacuum brakes. These would also be prevented by use of a continuous brake. Apart altogether from the increased capacity upon lines of railway which would result from the use of continuous brakes upon freight trains, it may be noted that the cost of introducing an acceptable system of automatic train control will be approximately doubled as the large majority of freight trains are unfitted with a continuous brake.

Electric Trains May Be Run Over M. K. & T. Line

A contract is now in process of negotiation between the Missouri, Kansas & Texas and electric power interests which if consummated will furnish electric passenger service between Dallas and Denton, Tex., a distance of 48 miles.

It is proposed that the electrical interests shall lease the trackage rights and that electrification of the line will in no way interfere with the operation of freight trains on the line, nor with the operation of through passenger trains. Z. G. Hopkins, manager, Department of Public Relations, M. K. & T., states that at the present time no change is contemplated in the operation of M. K. & T. trains.

C. E. Calder, president of the Texas Power & Light Company and of the Dallas Power & Light Company, stated that a contract with the railroad for electrification would comply with an agreement made with the city of Dallas for the construction of an interurban line at least 30 miles in length which the Dallas Railway is under bond to build in order to fulfil the terms of an agreement entered into in connection with the granting of the franchises to the Strickland-Hobson interests in 1917. Electrification of the M. K. & T. from Dallas to Denton, according to Mr. Calder, will be an economic proposition from the standpoint of the railroad, as well as the electrical interests.

The railroad now operates six passenger trains on this line, two of which are night trains. It is the intention of the power company to run electric trains hourly. The cost of electrifying has been estimated at between $800,000 and $1,000,000.

Meetings and Conventions

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamilton Ave., Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago. Annual meeting postponed.

Division V—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York.

American Railway Tool Foremen's Association.—R. D. Flecther, 1145 E. Marquette Road, Chicago.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Steubing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal. Next meeting October 10. William Carter, assistant general sales manager, Canadian Ingersoll-Rand Company, will present a paper on Some Elements in Economy in Air Compression.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention. November 6-8, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston Mass. October meeting postponed.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Next meeting October 26. Annual meeting. Election of officers. Smoker.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings second Friday each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting changed from September 12-15 to October 31 to November 3, 1922.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

H. C. Thomas, general superintendent of the United Alloy Steel Corporation, Canton, Ohio, has been promoted to assistant general manager.

The merger of the Bethlehem Steel Corporation and the Lackawanna Steel Company has been ratified at recent meetings of the stockholders of these companies.

The Chicago Flexible Shaft Company, Chicago, has opened a new district sales office at 305 Merchants Bank building, Indianapolis, Ind., in charge of F. W. Odemar.

The Economy Fuse & Manufacturing Company, Chicago, Ill., has moved its Detroit sales offices from the Majestic building in that city to the First National Bank building.

J. H. Rodger, western manager of the Safety Car Heating & Lighting Company, with headquarters at Chicago, has been promoted to vice-president with the same headquarters, in charge of that company's western business. Mr. Rodger entered the railway supply business in 1899, in the service of the Standard Coupler Company, which company he left in 1905 to become assistant to the president of the Monarch Machine Company, New York. In 1911, he became a sales agent of the Safety Car Heating & Lighting Company in its Chicago offices. He was promoted to western manager of that company in 1919, which position he was holding at the time of his recent promotion.

J. H. Rodger

Jay L. Hench, who resigned recently as Chicago district sales manager of the Lakawanna Steel Company, has formed Jay L. Hench & Co., 208 South La Salle street, Chicago, to engage in the purchase and sale of various iron and steel products including steel sheet piling, light and heavy tee rails, sheets, plates, shapes and bars with an additional line of open-hearth electric castings. Mr. Hench was born on April 11, 1885, at Hinsdale, Ill. He attended Cornell University from 1903 to 1905, specializing in iron and steel analysis. From 1905 to 1906 he was employed in the open-hearth and Bessemer departments of the Illinois Steel Company, and from 1906 until 1911 he was connected with the sales department of Joseph T. Ryerson & Son. He left in 1911 to become a sales agent of the Lackawanna Steel Company, having jurisdiction over the Indiana and Michigan territory. In May, 1919, he was promoted to district sales manager in charge of the Chicago office, which position he held up to the time of his resignation.

The Illinois Car Manufacturing Company, Hammond, Ind., has purchased the American Nut Company of Columbus, Ohio. It is said that the acquired business will be moved to Hammond.

The American Brake Shoe & Foundry Company, New York, has bought 17 acres of land at Portsmouth, Va., where it is proposed to erect a new plant in the near future for the manufacture of brake shoes.

The Norwalk Iron Works Company, South Norwalk, Conn., has been consolidated with the Automatic Carbonic Machine Company of Peoria, Ill. The plant and equipment of the latter company has been moved to South Norwalk.

The Ramapo Iron Works with plants at Hillburn and Niagara Falls, N. Y., and Niagara Falls, Ontario, and the Ajax Forge Company of Chicago with plants at Chicago and Superior, Wis.,

have been consolidated under the name of the Ramapo-Ajax Corporation, with J. B. Strong as president and headquarters at Hillburn. The control of the new company will be held by the American Brake Shoe & Foundry Company, New York.

J. M. Potter, treasurer of the Northwestern Malleable Iron Company, Milwaukee, Wis., died on September 6, at the age of 61 years. He had been connected with the above company for 32 years.

H. M. Aubrey, manager of the packing department of the Union Asbestos & Rubber Company, Chicago, has been appointed sales representative of that company in charge of the recently opened New York office, 30 Church street, New York City.

H. C. Mull, in charge of railway sales for both the Reliance Manufacturing Company, Chicago, and the Warren Tool & Forge Company, Warren, Ohio, with headquarters at Chicago, has resigned from the former and will hereafter represent only the latter, with headquarters at Warren, Ohio.

Frank Burr Smith, works manager of the Bullard Machine Tool Company, Bridgeport, Conn., died on August 16 at New Haven, Conn. Mr. Smith was born at Mohican Springs Farm, Fairfield, Conn., November 22, 1872, and obtained his early education in the public and high schools of Bridgeport, Conn. He entered the employ of the Bullard Machine Tool Company at its old Broad street plant in 1890 as a machinist apprentice. Upon completion of his apprenticeship he was connected with its engineering department. In 1894 he went to Colorado for his health and while there turned his attention to prospecting and mining for gold. Returning east in 1896, he was employed by various machine shops and at one time was prominently connected with the Atlantic Iron Works of Boston, Mass. He later entered the Laird Gold Production Company as a mechanical engineer in connection with its operations in the reclamation of gold from sea-water on the Maine coast. He was then transferred to the west coast, operating dry placer mines in Southern California. In 1903 he joined the De LaVergne Machine Company as an expert erection and installation engineer, and in 1911 returned to the Bullard Machine Tool Company, representing them in a sales capacity successively at Chicago, Cleveland, Philadelphia and in England. He then became manager of the employment and industrial relations department at the Broad street plant. When the Broad street plant was disbanded in 1920, and all manufacturing was transferred to the Black Rock plant, he was made works manager. Mr. Smith was prominently active in the mechanical development of Bullard products and his genius was further demonstrated by patents obtained in connection with mining and automotive industries. He was a member of the Algonquin Club of Bridgeport and of the Masonic Order.

F. B. Smith

C. T. Pratt, treasurer of the Brown Hoisting Machinery Company, Cleveland, Ohio, has resigned and A. C. Brown, president of that company, has assumed the additional duties of treasurer. J. F. Pierce has resigned as auditor and director of the same company. This latter vacancy probably will not be filled for the present.

The Walworth Realty Company, a subsidiary of the Walworth Manufacturing Company, Boston, Mass., manufacturers of pipe fittings, piping tools, etc., has awarded to Dwight P. Robinson & Co., Inc., New York, a contract for the design and construction of a warehouse, pipe shop and garage to be located at Jackson avenue, Long Island City, N. Y.

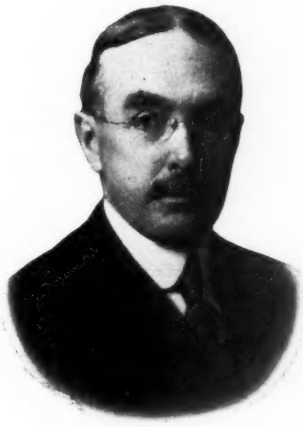
Russell, Holbrook & Henderson, 30 Church street, New York, has been appointed sales representatives for the territory in and near New York City of the Oilgear Company, Milwaukee, Wis. The Cadillac Machinery Company, Detroit, Mich., will handle Oilgear products in the state of Michigan and the R. E. Ellis Engineering Company, 621 Washington boulevard, Chicago, will represent the Oilgear Company in Chicago and the surrounding territory.

W. H. Woodin, president of the American Car & Foundry Company, New York, was appointed fuel administrator of the state of New York on September 5 by Governor Miller under the act of the extraordinary session of the Legislature. Mr. Woodin will serve without compensation and will succeed the governor's advisory coal commission.

The National Lock Washer Company, Newark, N. J., is building a new two-story brick structure, 84 ft. by 40 ft., at the corner of Pennington and Hermon streets, the top floor of which will be used for office purposes and the ground floor for shipments. The company is also putting up a steel storage building 100 ft. by 60 ft. for additional storage purposes, and is also rearranging the equipment in its fabricating machine shop and making general improvements throughout the entire plant.

John S. Ruble, who recently resigned as vice-president of the Austin Company, has been elected vice-president in charge of all construction of the H. K. Ferguson Company, engineers and builders, Cleveland, Ohio. Mr. Ruble was graduated in mechanical engineering from Pennsylvania State College in 1901. He was then engaged for four years in dock, ore storage and unloading equipment design and construction with Hoover & Mason, contracting engineers. He subsequently served for eight years as an engineer with the U. S. Steel Corporation at various places, then as construction engineer for the Tennessee Coal, Iron & Railroad Company, at Birmingham, Ala.

Frederick W. Cooke, formerly general manager of the Cooke Locomotive Works, died on August 30 at his summer home at Quogue, Long Island. Mr. Cooke was born on July 10, 1860, at Paterson, N. J., and graduated from Stevens Institute in 1882. He served as vice-president and general manager of the Cooke Works from 1883 until the plant was sold in 1901 to the American Locomotive Company and then was general manager until his resignation in 1912. The Cooke Works originated as the Charles Danforth Company, manufacturer of cotton machinery at Paterson, N. J. In 1852 John Cooke became associated with these interests and a new company was organized in July of that year under the name of Danforth, Cooke & Company, Paterson, N. J., to build machinery and locomotives; and it continued under this name until 1865 when the name was changed to the Danforth Locomotive & Machine Company, of which John Cooke was the head and active manager of the locomotive branch. The business soon outgrew the machine interest and the latter was given up entirely some years later. John Cooke died in February, 1882, and was succeeded by his brother, James Cooke, formerly superintendent. The latter died on August 2, 1883, shortly after which date the stock control passed into the hands of the Cookes and the corporate name was changed to the Cooke Locomotive & Machine Company with John S. Cooke, president, and Frederick W. Cooke, vice-president and general manager. The business increased and work was started in 1888 on new works on the present site. In 1901 the works were sold to the American Locomotive Company and became the Cooke Works of that company. Mr. Cooke continued as general manager until his retirement in 1912. During the late war Frederick W. Cooke took an active part in the raising of funds for the various war reliefs.



Frederick W. Cooke

John H. Flagler, who organized the National Tube Company and served as its president until it was merged with the United

States Steel Corporation, died on September 8 at his country home in Greenwich, Conn.

H. A. Matthews, formerly sales manager of the railway division of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., has been elected a vice-president, sales railway division. Mr. Matthews entered the railway supply business in 1912 with the U. S. Light & Heat Corporation at Chicago. Prior to that time he had been employed by the Lake Shore & Michigan Southern as clerk to the general superintendent at Cleveland, and later entered the services of the Pullman Company. For seven years he was secretary to the president of the Pullman Company, which position he held up to the time he joined the U. S. L. forces at Chicago. In 1917 he was transferred to the factory at Niagara Falls and placed in charge of the railway sales department.

The American Flexible Bolt Company announces a complete reorganization with general offices at Zelienople, Pa. The reorganized company retains the original charter but has added additional working capital. There is also a complete change in the board of directors. Stephen Robinson, Jr., is now president and in charge of sales; H. T. Frauenheim, vice-president; Chas. A. Seley, consulting engineer and district representative at Chicago; J. A. Trainor, Eastern district representative; L. W. Widmeier, Cleveland district representative; E. F. Boyle, Western district representative; H. G. Doran & Co., Chicago, representative; W. F. Heacock, Chicago, representative. The plant management will be under the supervision of L. Finegan, formerly shop superintendent, Mt. Clare shops, Baltimore & Ohio. The purchasing will be handled by Jas. F. McGann at Zelienople, Pa.

Federal Trade Commission Opposes Steel Merger

The Federal Trade Commission on August 31 issued a formal complaint charging that the proposed merger of the Midvale, Republic and Inland steel companies would be an unfair method of competition in violation of the federal trade commission act. The companies are given 30 days to file answers, after which hearings will be held. The commission says that after preliminary inquiry it has reason to believe that the merger of these three competing companies will center the control of some 35 corporations in one group and eliminate competition, restrain trade and tend to create monopoly in iron and steel products in interstate commerce. The Department of Justice had previously made a favorable report on the proposed merger. Commissioner Van Fleet voted against the issue of the complaint.

TRADE PUBLICATIONS

Milling Machine.—The Pawling & Harnischfeger Company, Milwaukee, Wis., has issued bulletin No. 3-T covering a new table type horizontal boring, drilling and milling machine.

Drinking Water Systems.—A folder entitled, "A Neglected Source of Economy," has recently been issued by the Armstrong Cork & Insulation Company, Pittsburgh, Pa., which deals with the savings that can be effected in shops by the use of refrigerated drinking water systems.

Insulating Compounds.—A small 16-page booklet has just been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., which describes the insulating and soldering compounds manufactured by that company. The materials treated in the publication are baking varnishes, air-drying varnishes, insulating compounds, finishing materials, insulating glue, soldering flux, and lubricating oil.

Boiler Tube Cleaners.—The problem of eliminating the heat waste due to the formation of scale in boilers is dealt with at length in a catalogue sent out by the Liberty Manufacturing Company, Pittsburgh, Pa. Water turbine cleaners of various types, equipped with different style heads are described with the special uses for which they are best adapted. Pneumatic cleaners of high power in which steam can also be used are also illustrated and described. Mention is made of pneumatic cleaners for fire tube and return tubular boilers, arch tube cleaners and special cutting heads.

Schoop Metal Spraying Process.—The Metals Coating Company of America, Philadelphia, Pa., has recently issued a large size, 18-page, illustrated bulletin descriptive of the metal spraying process developed by that company. The bulletin discusses fully the details of the process and the equipment, showing both by text and by numerous illustrations the various forms and classes of structures, such as bridges, pipe, car frames, towers, etc., which can be treated by this process of spraying on a thin coating of such metals as zinc, lead, aluminum, tin, copper, etc., for protection against corrosion and other destructive agents.

Direct Drive Axle Generator.—Specifications and description of a direct drive axle generator and system for the electric lighting of railway cars are contained in a 16-page bulletin published by the Products Distributing Corporation, 360 Madison avenue, New York, N. Y. The equipment described in this bulletin will be offered to the railroads by the above company and will be built by the Wagner Electric Company, St. Louis, under the E. M. Fitz patents. The booklet is profusely illustrated with photographs and line drawings and contains brief specifications and descriptions of the equipment. A blue print insert is included on which curves are shown giving the characteristics of the generator.

Train Lighting Equipment.—The Safety Car Heating & Lighting Company has recently issued two new catalogues and an elaborate folder which will be of interest to anyone connected with train lighting work and of especial interest to the users of safety equipment. One of the catalogues bears the title, "Operation of Under-Frame Car Lighting Equipment" and the other, "Pintsch Gas Car Lighting Fixtures." Both catalogues are profusely illustrated and contain 60 and 52 pages respectively. A novel and useful feature has been introduced in the Under-Frame catalogue, which consists of cross-indexed tables which show at a glance which of the various generator parts can be used interchangeably on two or more of the ten types of generators manufactured by the Safety Company.

Foundry Equipment.—The Whiting Corporation, Harvey, Ill., has issued four new catalogues which supersede previous issues on the same subjects. These cover the following types of apparatus: Catalogue No. 161, ladles, lists a complete line of metal and slag ladles, both plain and geared, of the hand, crane, truck, trolley and reservoir types; Catalogue No. 162, tumbling mills, describing many sizes and types of mills for cleaning castings, with information in regard to construction and illustrations of a number of installations; Catalogue No. 163, core oven equipment, is devoted to core ovens together with racks, cars, trucks and core benches, and includes a number of illustrations of different types of core rooms; Catalogue No. 164, trucks and turntables, covers details of industrial railways and their equipment for foundry uses.

Certified Malleable Iron.—The daily service that is being rendered by one of the most important branches of the iron and steel business is outlined in a book, entitled "Certified Malleable in Transportation and Industry," issued by the American Malleable Castings Association, Cleveland, Ohio. It tells in an interesting way the story of certified malleable castings and their contribution to safety, strength and economy.

The book points out the great responsibility that malleable castings assume when used for vital parts of railway and general industrial equipment, and also describes the methods employed by the American Malleable Castings Association in bringing the product of its members to a uniformly high standard and maintaining it at that point. By standardizing the manufacturing processes of an industry, scientists and practical foundrymen, operating through the American Malleable Castings Association, have produced certified malleable, a superior metal assuring high strength and ductility.

In the strict supervision of the product of its members, the work of the association parallels the activities of the trade guilds of the middle ages whose chief reason for existence was the guardianship of the consumers' interests. They saw to it that their members conformed to adopted standards of material and craftsmanship, and their supervision was accepted by the careful buyer as a certain guaranty of quality. The book is a complete treatise on the subject of malleable iron and gives information regarding the properties of the metal that are of interest and value to all users.

EQUIPMENT AND SHOPS

Locomotive Orders

THE ATLANTIC COAST LINE has ordered 25 Pacific type locomotives from the Baldwin Locomotive Works.

THE ST. LOUIS-SAN FRANCISCO has ordered 35 Mikado and 15 Mountain type locomotives from the Baldwin Locomotive Works.

THE CHESAPEAKE & OHIO has ordered 50 Mallet type locomotives from the American Locomotive Company to be built at its Schenectady, N. Y., works.

THE PENNSYLVANIA has placed orders for 15 new locomotives for passenger service to be built by the company's forces at Altoona, and for 100 freight locomotives to be built by the Baldwin Locomotive Works.

THE DELAWARE, LACKAWANNA & WESTERN has ordered 15 Mikado type locomotives from the American Locomotive Company. These locomotives will have 28 by 32 in. cylinders and a total weight in working order of 355,000 lb.

THE BALTIMORE & OHIO has placed an order for 50 Mikado type locomotives with the Baldwin Locomotive Works. These are in addition to the 15 Pacific type ordered from the Baldwin Locomotive Works as noted in the September issue.

THE NORFOLK & WESTERN has ordered 30 Mallet type locomotives from the American Locomotive Company and 12 Mountain type locomotives from the Baldwin Locomotive Works. The Mallet type will have 25 and 39 by 32 in. cylinders and a total weight in working order of 531,000 lb.

THE NEW YORK CENTRAL has ordered 90 locomotives—50 Pacific type and 40 Mikado type. The Pacific locomotives will have 23½ by 26 in. cylinders and a total weight in working order of 288,000 lb., and the Mikado locomotives will have 28 by 30 in. cylinders and a total weight in working order of 340,000 lb.

THE CHICAGO & NORTH WESTERN has ordered 40 Mikado type and 10 Pacific type locomotives from the American Locomotive Company. The Mikados will have 27 in. by 32 in. cylinders and a total weight in working order of 307,000 lb., and the Pacifics will have 25 in. by 28 in. cylinders and a total weight in working order of 273,000 lb.

THE TEXAS & PACIFIC has ordered 8 Pacific type and 8 switching locomotives from the American Locomotive Company. The Pacific type will have 26 by 28 in. cylinders and a total weight in working order of 281,000 lb. The six-wheel switching locomotives will have 21 by 28 in. cylinders and a total weight in working order of 164,000 lb.

THE MISSOURI-PACIFIC has ordered 46 Mikado type and 4 Mountain type locomotives, from the American Locomotive Company. The Mikado type will have 27 in. by 32 in. cylinders and a total weight in working order of 320,000 lb., and the Mountain type will have 27 in. by 30 in. cylinders and a total weight in working order of 335,000 lb.

THE LOUISVILLE & NASHVILLE, reported in the September *Railway Mechanical Engineer* as having ordered 30 Mikado type locomotives, has ordered 12 additional Mikado locomotives from the American Locomotive Company. These locomotives will have 27 in. by 32 in. cylinders and a total weight in working order of 320,000 lb. This road ordered also 8 Mikado type locomotives from the Baldwin Locomotive Works.

Locomotive Repairs

THE ERIE will have repairs made to about 100 locomotives at the shops of the Crucible Steel Company, Harrison, N. J.

Freight Car Orders

THE NORTHERN PACIFIC has ordered 1,000 center constructions from the Western Steel Car & Foundry Company.

THE BALTIMORE & OHIO has ordered 1,000 steel hopper cars of 55 tons' capacity from the American Car & Foundry Company.

THE TEXAS & PACIFIC has placed an order with the American Car & Foundry Company for 150, 10,000 gal. tank cars of 50 tons' capacity.

THE CZARNIKOW-RIONDA COMPANY, 112 Wall street, New York City, has ordered 40 cane cars of 30 tons' capacity from the Magor Car Corporation.

THE PHILLIPS PETROLEUM COMPANY, Bartlesville, Okla., has ordered 75 insulated tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

THE ROXANNA PETROLEUM COMPANY, St. Louis, Mo., has ordered 50 insulated tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

THE CHAMPLIN REFINING COMPANY, Enid, Okla., has ordered 500 tank cars of 8,000 gal. capacity with 40-ton trucks, from the Pennsylvania Tank Car Company.

The ILLINOIS CENTRAL has ordered 75 caboose cars from the American Car & Foundry Company. The cars are to have steel underframes and are to have a capacity of 30,000 lb.

ST. LOUIS-SAN FRANCISCO has ordered 1,000 hopper cars from the Chickasaw Ship Building Company and 500 hopper cars from the Pullman Company; 1,200 box cars and 1,000 hopper car bodies of 55 tons' capacity from the American Car & Foundry Company and 300 stock cars from the Mount Vernon Car Manufacturing Company.

Freight Car Repairs

THE WABASH will repair 500 box cars, 300 stock cars and 250 automobile cars.

THE NEW YORK CENTRAL has let contracts for repairs to a total of 11,100 cars as follows:

New York Central

2,000 box, Ryan Car Company.
1,000 box, American Car & Foundry Company.
1,000 gondolas, American Car & Foundry Company.
2,000 box, Illinois Car & Manufacturing Company.
500 box, Buffalo Steel Car Company.
1,500 box, Streator Car Company.
400 gondolas, Steel Car Company.

Michigan Central

200 box, Streator Car Company.
1,000 box, Illinois Car & Manufacturing Company.

Toledo & Ohio Central

500 gondolas, Ralston Steel Car Company.

Cleveland, Cincinnati, Chicago & St. Louis

1,000 box, American Car & Foundry Company.

Passenger Cars

THE CHICAGO & EASTERN ILLINOIS has ordered 17 steel baggage cars, 70 ft. long, from the Pullman Company.

THE ATLANTIC COAST LINE, reported in the July *Railway Mechanical Engineer* as having ordered 20 express cars and 10 coaches from the Bethlehem Shipbuilding Corporation, Harlan plant, has increased its order to 25 steel express cars and to 25 steel coaches.

Machinery and Tools

THE ILLINOIS CENTRAL has completed negotiations for $250,000 worth of machine tools, exclusive of motors.

THE ATCHISON, TOPEKA & SANTA FE has ordered a 10-ton hand power crane from the Whiting Corporation.

THE UNION PACIFIC has placed orders with various companies for approximately $200,000 worth of machine tools.

THE MISSOURI PACIFIC has ordered one 2,500-lb. single frame steam hammer from the Niles-Bement-Pond Company.

THE LOS ANGELES RAILWAY CORPORATION has ordered a No. 1 car wheel lathe from the Niles-Bement-Pond Company.

THE CHICAGO, BURLINGTON & QUINCY has placed an order with the Whiting Corporation for two 125-ton electric overhead traveling cranes, one 125-ton hoist and one auxiliary 15-ton hoist.

THE CHICAGO & NORTH WESTERN has ordered a coal handling gantry crane with a 1½ yd. bucket from the Milwaukee Electric

Crane & Manufacturing Company. The crane will be leased to the Armour Grain Company for use at its grain elevator in South Chicago.

Shops and Terminals

DENVER & RIO GRANDE WESTERN.—The proposed rehabilitation program budget includes $2,736,900 for new shops.

ILLINOIS CENTRAL.—This company has awarded a contract for the rebuilding of its water treating plants at Dunlap, Iowa, and Manchester, and at La Salle, Ill., and Scales Mound to the International Filter Company, Chicago.

UNION PACIFIC.—This company has awarded a contract to the Graver Corporation of Chicago, for the erection of a 200,000-gal. steel water storage tank at Ogallala, Neb., and an 800,000-gal. steel water storage tank at Council Bluffs, Iowa.

LAKE SUPERIOR & ISHPEMING.—This company will construct a steel repair shop, 69 ft. by 301 ft., a paint and coach shop, 48 ft. by 100 ft., and a woodmill, 47 ft. by 100 ft., at Marquette, Mich., the total cost of which is estimated at $250,000.

THE RICHMOND, FREDERICKSBURG & POTOMAC has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of two 1,000-ton coaling stations to be erected at Acca yard, Richmond, Va., and Potomac yard, Alexandria.

ATCHISON, TOPEKA & SANTA FE.—This company has awarded a contract for the construction of a new boiler shop at Albuquerque, N. M., to C. A. Fellows & Co., Los Angeles, Cal.; also a contract for a machine shop at Waynoka, Okla., to E. Ware, El Paso, Tex. Contracts for the sash for these shops have been awarded to the Truscon Steel Company.

PERSONAL MENTION

GENERAL

ROBERT COLLETT has been appointed superintendent of fuel and locomotive performance of the New York Central with headquarters at New York.

J. J. HANLIN has been appointed assistant superintendent of motive power of the Seaboard Air Line, with headquarters at Portsmouth, Va.

B. F. BARDO has been appointed superintendent of electric transmission on the New Haven in charge of operation and maintenance of the wire plant between New York and Cedar Hill with headquarters at Cos Cob, Conn., reporting to H. A. Shepard, general superintendent of electric transmission and communication. Mr. Bardo was born in Wilkes-Barre, Pa., December 16, 1889. He was educated in the Morris High School, New York City, and Cornell University, being graduated from the latter institution with a degree of mechanical engineer in 1913. After graduation he served for a little more than a year in the testing department of the General Electric Company at Schenectady, N. Y., and at Pittsfield, Mass. In August, 1914, he entered the services of the New York, New Haven & Hartford in the office of the superintendent of power. In October, 1915, Mr. Bardo was appointed inspector of power plants and in November, 1917, was promoted to engineer of power plants, serving in that capacity until his present appointment.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

R. D. SMITH has been appointed master mechanic of the Interstate Railroad, with headquarters at Andover, Va., succeeding O. S. Kuhn, resigned.

SHOP AND ENGINEHOUSE

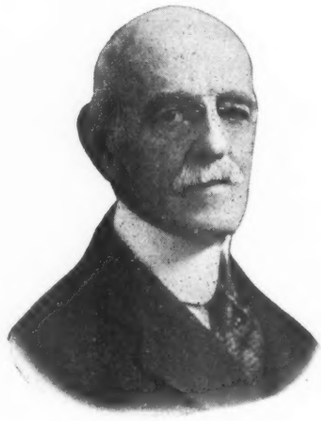
H. H. STEPHENS, mechanical superintendent of the Southern lines of the Western district of the Atchison, Topeka & Santa Fe, with headquarters at Amarillo, Tex., has been appointed superintendent of shops at Topeka, Kan., to succeed W. B. Deveny, deceased. E. E Machovec, division master mechanic, with headquarters at Argentine, Kan., has been promoted to mechanical superintendent of the Southern lines of the Western district with headquarters at Amarillo, Tex., to succeed Mr. Stephens. W. R. Harrison, master mechanic with headquarters at Chanute, Kan., has been transferred to Argentine, Kan., in place of Mr. Machovec. G. F. Tier, general foreman at Emporia, Kan., has been promoted to master mechanic with headquarters at Chanute, in place of Mr. Harrison.

PURCHASING AND STORES

GEORGE KEFER, whose appointment as purchasing agent of the Long Island with headquarters at Jamaica, Queensborough, New York City, was announced in the September *Railway Mechanical Engineer*, was born in New York City on November 22, 1870. His early education was obtained in the public schools of Whitestone, Long Island. After graduation in 1885 Mr. Kefer entered the employ of the Long Island Railroad as a messenger in the accounting department, then located at Long Island City. He subsequently served in various clerical capacities in the same department. On November 1, 1889, he was appointed chief clerk to the purchasing agent, which position he held for about 33 years until his recent promotion to purchasing agent upon the retirement of Harrison B. Hodges.

G. Kefer

HARRISON B. HODGES, purchasing agent for the Long Island at Jamaica, N. Y., retired on September 1 under the pension rules of the company. Mr. Hodges was born at Barre, Mass., on August 14, 1858, and after completing his grammar school education he attended the Boston Latin School and then specialized in the study of chemistry at the Universities of Leipsic, Heidelberg and Bonn in Germany. He also studied the engineering side of chemistry and building construction at the Polytechnicum in Aix-la-Chapel. He was then for five years instructor in chemistry and German at the Harvard University. In 1886 Mr. Hodges began railway work as chemist and superintendent of tests on the Union Pacific, remaining with that road until 1892 when he went to the Baltimore & Ohio as engineer of tests. In 1895 he was appointed superintendent of tests on the Southern Railway and on January 1, 1897, he became purchasing agent of the Long Island Railroad.



H. B. Hodges

OBITUARY

W. B. DEVENY, superintendent of shops of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., died on August 22 as the result of an automobile accident.

JOHN R. SCHRADER, general car foreman of the New York Central at Mott Haven, N. Y., died Friday, August 11. He was also second vice-president of the Central Railway Club.

ROBERT QUAYLE, who retired as general superintendent of motive power and machinery of the Chicago & North Western on May 1, 1922, died at his home in Oak Park, Ill., on September 13 at the age of 69.